T-64 BATTLE TANK

The Cold War's Most Secret Tank

STEVEN J. ZALOGA

ILLUSTRATED BY IAN PALMER

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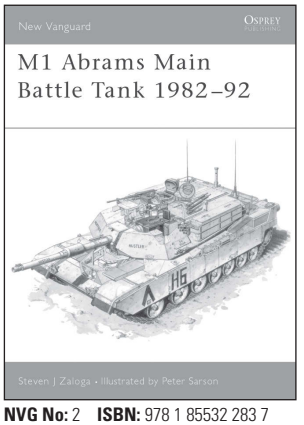
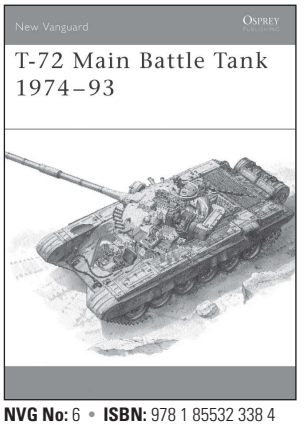


NVG No: 2 **ISBN:** 978 1 85532 283 7



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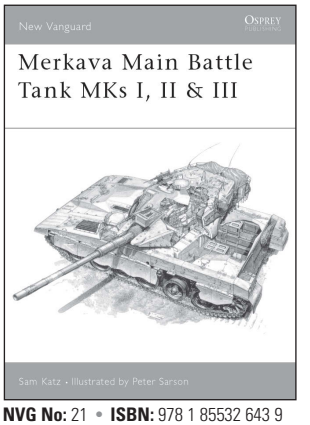

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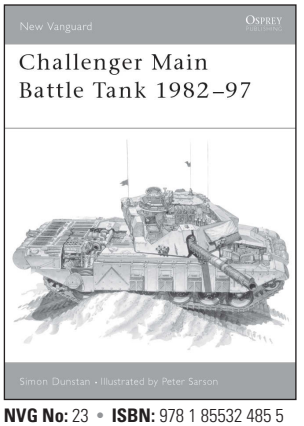

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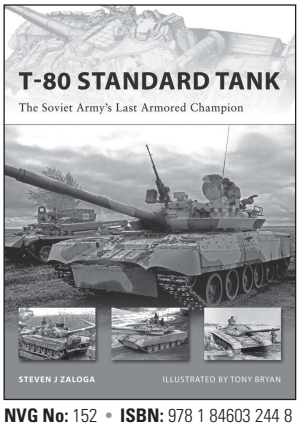

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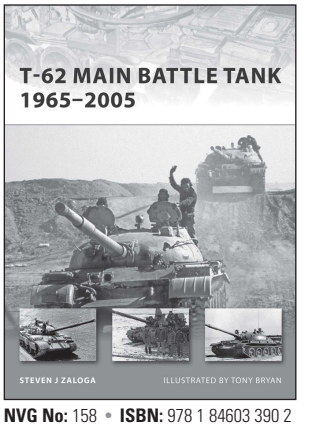

NVG No: 158 • **ISBN:** 978 1 84603 390 2

NEW VANGUARD 223

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This electronic edition published 2015 by Bloomsbury Publishing Plc

First published in Great Britain in 2015 by Osprey Publishing,
PO Box 883, Oxford, OX1 9PL, UK
PO Box 3985, New York, NY 10185-3985, USA
E-mail: info@ospreypublishing.com

Osprey Publishing, part of Bloomsbury Publishing Plc

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A CIP catalog record for this book is available from the British Library

ISBN (print): 978-1-4728-0628-4
ISBN (ePub): 978-1-4728-0630-7
ISBN (ePDF): 978-1-4728-0629-1

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AUTHOR'S NOTE

The author would especially like to thank Stephen "Cookie" Sewell for his extensive help on this project. Thanks also go to Jim Kinnear, Wojciech Luczak, and Bartosz Musialowicz for their help with photos for this book.

GLOSSARY

BTRZ	*Bronetankvo-remontniy zavod*: Armored Vehicle Rebuilding Factory
GBTU	*Glavnoe bronetankovoe upravleniye*: Main Armored Vehicle Directorate
GSVG	*Gruppa sovetskikh voysk v Germanii:* GSFG: Group of Soviet Forces Germany
KBM	*Konstruktorskoe byuro mashinostroyenie*: Industrial Design Bureau (aka SKB-4) in Kolomna
KBP	*Konstruktorskoe byuro priborostroyeniya*: Instrument Industry Design Bureau in Tula
MOP	*Ministerstvo oboronnoy promyshlennosti*: Ministry of Defense Production; in charge of tank production after 1957
MTrM	*Ministerstvo transportnogo mashinostroeniye*: Ministry of Transport Machinery Construction; in charge of tank production through May 1957
MT-T	*Mnogotselevoy transporter-tyagach*: Multirole transporter-tractor
NII	*Nauchno-ispitatelniy institut*: Scientific Research Institute
NST	*Novoe-sredniy tank*: New Medium Tank
OKB	*Opitnoye konstruktorskoe byuro*: Experimental Design Bureau
SKB	*Spetsialnoe konstruktorskoe byuro*: Special Design Bureau
TsKB	*Tsentralnoe konstruktorskoe byuro*: Central Design Bureau
TsNII	*Tsentralnoe nauchno-ispitatelniy institut*: Central Scientific Research Institute

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T-64 BATTLE TANK

THE COLD WAR'S MOST SECRET TANK

INTRODUCTION

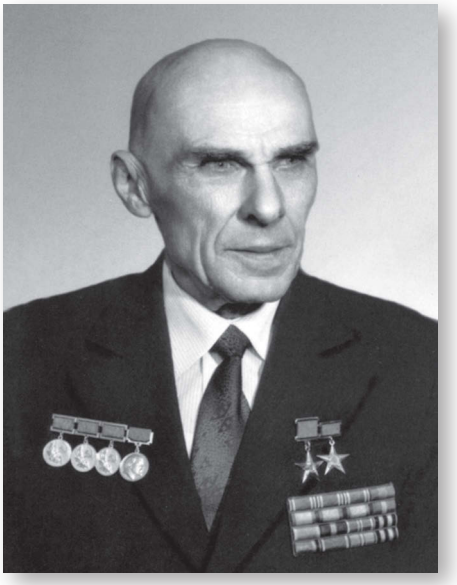
The Soviet T-64 tank was one of the most revolutionary tank designs of the Cold War. It pioneered many of the technologies that would become commonplace in the later years of the Cold War, including advanced armor and guided tank projectiles. It had the firepower and armor of NATO tanks of the 1960s, but was smaller and lighter than many World War II tanks such as the Panther, M26 Pershing or Centurion. The design was considered so revolutionary and advanced that the Kremlin never permitted its export. In spite of its many attributes, the T-64 was plagued with problems well into the 1970s. As a result, rival tank plants refused to produce the T-64 and instead offered modified alternatives, Nizhni-Tagil's T-72 and Leningrad's T-80.[1] The T-64 remained the spearhead for Soviet tank units facing NATO, and was the principal tank in the best Soviet units in East Germany and the western Soviet military districts into the mid-1980s, when the newer T-80 began to appear.

A T-64A tank on parade in Magdeburg, East Germany during the May 1984 Victory Day parade.

The T-64 tank was the brainchild of one man, Aleksandr Morozov, who headed the tank design bureau at Kharkov's Malyshev tank plant.[2] Morozov had taken on this role in 1940 following the death of Mikhail Koshkin, who had led the design of the legendary T-34 tank. Following the German invasion of the Soviet Union in June 1941, the Kharkov tank plant was transferred to the Factory No. 183 railroad plant in Nizhni-Tagil in the Urals. This plant became the center of T-34 development and production during World War II and eventually became known as Uralvagonzavod (Urals Rail-Car Factory) or UVZ. Following the liberation of Kharkov, the devastated tank plant was rebuilt in 1944 as Factory No. 75

1 For more details, see Osprey New Vanguards 6 and 152: Steven J. Zaloga, *T-72 Main Battle Tank 1974–1993* (1993); *T-80 Standard Tank: The Soviet Army's Last Armored Champion* (2009).
2 Soviet tank design bureaus and tank assembly plants were renamed numerous times from World War II to the present, so simplified names for these facilities will be used in this book to avoid confusion.

and served as the production hub for Morozov's most recent design, the T-44 medium tank, starting in November 1944. The T-44 was very short-lived, as it was armed with the same 85mm gun as the previous T-34-85 tank. As a result, Morozov led the design effort on a derivative of this tank, the T-54, armed with the more powerful 100mm gun. Prototypes were tested in early 1945 and the T-54 eventually became the predominant Soviet tank of the early Cold War period. In 1951, Morozov left Nizhni-Tagil for medical treatment in Moscow and was subsequently assigned to re-establish a tank design bureau in Kharkov using a cadre of engineers from Nizhni-Tagil. A rump design bureau led by Leonid Kartsev remained at UVZ in Nizhni-Tagil. As will be recounted later, an intense rivalry developed between these two design centers that warped the course of Soviet tank development through much of the Cold War. Morozov had ambitions to develop a radical new tank design to eventually replace the T-54, and the first mention of the new T-64 appeared in his notes in 1947.



Alexander A. Morozov was the Soviet Union's most prolific and influential tank designer, leading the development of the T-44, T-54, and T-64 tanks.

NST: NEW MEDIUM TANK

Although Morozov had done some preliminary work on a new tank while at Nizhni-Tagil, it was not until he was assigned to Kharkov that any formal work on the project officially began. The effort to develop the NST (*Novoe-sredniy tank*: New Medium Tank) started to crystallize in May 1952. In discussions with the army, the basic requirements included use of the new 100mm D-54 gun, guaranteed running life of 3,000 kilometers, engine life of 400 hours, and the use of a hydro-mechanical transmission. The NST program received approval from Moscow on November 17, 1952 and was given the industrial designator of Obiekt 430 (Object 430).

Morozov's idea for the Obiekt 430 NST was a tank within the size and weight envelope of the existing T-54, but with considerably better armor, firepower, and mobility. He began approaching other design institutes for

The automotive test-bed for the Obiekt 430 was built on a surplus OT-54 tank chassis. The initial configuration used larger road-wheels in the first and last stations, a practice abandoned in the later designs.

The Obiekt 430 turret accommodated a traditional three-man crew with the 100mm D-54TS gun.

more advanced technologies that could be incorporated into the design. The 100mm D-54T gun was a new weapon that had been designed from an outset as a tank gun, unlike the existing D-10T on the T-54, which had been developed from previous artillery weapons. The breech and chamber had been designed to withstand greater bore pressures, offering a muzzle energy of 845 ton-meters, about 30 percent greater muzzle energy than the D-10T and a third higher than the contemporary British 105mm L7 gun. At a range of 1,000 meters, the D-54T 100mm projectile could penetrate 235mm vertical armor plate. This gun was later given the industrial designator U-8T.

To improve its accuracy, the improved D-54TS added the Metel two-axis stabilization system. The other novel feature of the armament package was a mechanical loader accommodating 16–18 rounds. The Obiekt 430 design also included a wide-base coincidence rangefinder to improve long-range gun accuracy. Gun sights since World War II had reticles etched into the optics that the gunner could use to estimate range. Soviet studies estimated that such stadia rangefinders had an error rate of 15 percent compared with about 2.6 percent for coincidence rangefinders. An improved rangefinder was a desirable feature on the new tank since its more powerful gun could reach further than the existing 100mm D-10T guns. The wide-base optical rangefinders added considerable cost and complexity to the new tank, and Soviet studies of recent conflicts concluded that tank engagements could occur at ranges over 1,200m where the new rangefinder would be most valuable. The average tank engagement during the Indo-Pakistani War in Kashmir in 1965 was 600–1,200 meters; 1967 Mid-East war engagements were typically at 900–1,100 meters and only in isolated cases at 3,000 meters. Terrain studies of central Europe found that 50 percent of targets would be acquired at 1,000 meters and another 30 percent at 2,000 meters. Even in the flat northern part of West Germany, 83 percent of targets could be spotted at ranges of 3,000 meters or less. Aside from the baseline Obiekt 430 tank, an alternative was proposed as the Obiekt 430U, with glacis armor increased from 120mm to 160mm, the use of the 122mm D-25TS gun, and a radar-based range-finding system to supplement the optical sights.

In terms of protection, the Obiekt 430 was the first tank design to use composite armor. The glacis plate used steel armor plate in a sandwich configuration with layers of ceramic in between the steel. This type of armor

offered superior protection against shaped-charge warheads such as the wartime German Panzerfaust, or the newer generations of NATO HEAT (high explosive antitank) tank projectiles and antitank missiles. The Obiekt 430 was designed from the outset to resist the effects of tactical nuclear weapons. This included antiradiation cladding as well as various schemes to filter the air in the fighting compartment and to ensure that the tank hatches and opening could be quickly closed in the event of a nuclear blast.

The T-54 used a modified version of the same V-2 diesel that had powered the T-34 since 1940. Morozov began discussions with Prof A. D. Charomskiy about a new family of advanced diesel engines that used a 2-cycle, opposed-piston configuration. Opposed-piston diesel engines had appeared in Russia as early as 1907, and more modern configurations had emerged during World War II, including the German Jumo 205 aircraft engine and the American Fairbanks-Morse marine and locomotive engines. The Jumo 205 was the principal inspiration for the new Soviet engine, as this unusual engine configuration promised excellent power output from a compact and light engine, satisfying Morozov's desire to minimize the size and weight of the NST. The original Obiekt 430 used Charomskiy's 4TPD 480hp engine, but by 1953 the modified project included the more powerful 600hp 5TD. More conventional diesel engines were considered but ultimately rejected, including the Barnaul plant's 580 horsepower 8D12-P diesel. The existing V-54 diesel engine used in the T-54 family had a warrantied life of 250 hours, and the requirements for the Obiekt 430 powerplant called for a durability of at least 300 hours and eventually 500 hours once mature.

The lightweight suspension and running-gear accounted for only 16 percent of the tank's weight compared with the usual 20 percent. The small diameter wheels used internal rubber buffers instead of the usual rubber tires, a style pioneered by the KV heavy tank of 1940. On the original Obiekt 430, some exotic options were tested including titanium wheels, but the production versions switched back to steel. The track was a new and expensive double pin design.

The preliminary design for the Obiekt 430 was presented in Moscow in February 1954 to the main customers, the MTrM (Ministry of Transport Machinery Construction), which managed the Soviet tank industry, and the GBTU (Main Armored Vehicle Directorate), which administered the army's tank programs. Morozov strongly supported the use of the novel Charomskiy-opposed piston engine, but there was considerable skepticism in Moscow as to whether the configuration was sufficiently mature. A review of the program later in the year by the Council of Ministers was harshly critical of work on the engine to date, but accepted the advances it offered and authorized additional development work. The army was skeptical about the use of a mechanical autoloader and wanted enough space left in the turret for a human loader.

The Obiekt 430 program won the support of the *éminence grise* of the Soviet

One of the innovations in the T-64 design was the use of combination armor in the turret. The original configuration seen in this Soviet illustration consisted of ceramic balls cast inside the turret armor. Difficulties in maintaining the shape of the matrix led to its abandonment in favor of a cast aluminum cavity in the later production tanks.

defense industry, Dmitry Ustinov. Much like Albert Speer in Nazi Germany, Ustinov led the Soviet defense industries during World War II. After Stalin's death, he led the new Ministry for Defense Industries and subsequently the Military Industrial Commission (VPK). Ustinov kept a close eye on all major weapons programs and he frequently overruled army leaders about new designs. The senior army leaders tended to favor conservative, simple weapons since they would be operated by conscript troops with modest training. Ustinov favored more innovative weapons such as the T-64, with the aim of keeping the Soviet Army ahead of NATO in the technology race.

The Council of Ministers finally approved the engineering development of the Obiekt 430 on May 6, 1955, authorizing the construction of five prototypes by 1957. There was a general consensus that the Obiekt 430 represented the most advanced features of any Soviet tank design being offered at the time by the various design bureaus. A wooden mock-up of the Obiekt 430 was ready by May 1956 and inspected by a delegation from Moscow. The main alternative to the Obiekt 430 was Nizhni-Tagil's Obiekt 140. This was a modified version of the T-54 armed with the D-54TS 100mm gun and fitted with a new suspension system; it would eventually lead to the T-62 tank. While Morozov and the Kharkov plant pushed for revolutionary new designs, Kartsev and Nizhni-Tagil preferred simpler, evolutionary designs.

The first Obiekt 430 prototypes entered trials near Kharkov in August 1958 and three prototypes were handed over to the army's NIIBT proving ground at Kubinka in January 1959. The new engine and power-train displayed numerous problems during the tests. As a result, a number of improvements were made to the prototypes, and these Obiekt 430M were subjected to another round of trials starting in late 1959. It is worth noting that the problems with the opposed-piston engine were not unique to the T-64. Britain had also been inspired by the potential of the Jumo 205 and had selected the Leyland L60, based on the Jumo, for the new Chieftain tank. The British engine proved to be every bit as troublesome as its Soviet counterpart.

REFINING THE DESIGN: OBIEKT 432

There was considerable turmoil in the Soviet Army in 1958–59, when it was discovered that NATO was beginning to deploy the powerful new British 105mm gun. At the same time, a new generation of thickly armored NATO

A

T-64 MEDIUM TANK (OBIEKT 432), CARPATHIAN MILITARY DISTRICT, 1968

The T-64 first went into troop trials with units in the western Soviet military districts, mainly in Ukraine due to their proximity to the factory. The T-64 was finished in the usual Soviet camouflage green (*Zeleno-zashchitniy*). Tactical markings usually included a three-digit tactical side number (*Bortovoy nomer*). The Soviet numbering practice was deliberately non-standard and varied from division to division. The two most common patterns were to use the numbers in the sequence Battalion+Company+Tank or Company+Tank number (two digits). This marking pattern is unusual, with an added "2" on the turret front, possibly indicating battalion, with the three-digit set indicating company and individual tank. The diamond was a frequent tactical symbol on Soviet tanks, usually assigned on a temporary basis by the division during wargames for traffic regulation. In some cases, the division would select a simple geometric shape, and additional numbers or symbols would be added inside to distinguish subunits.

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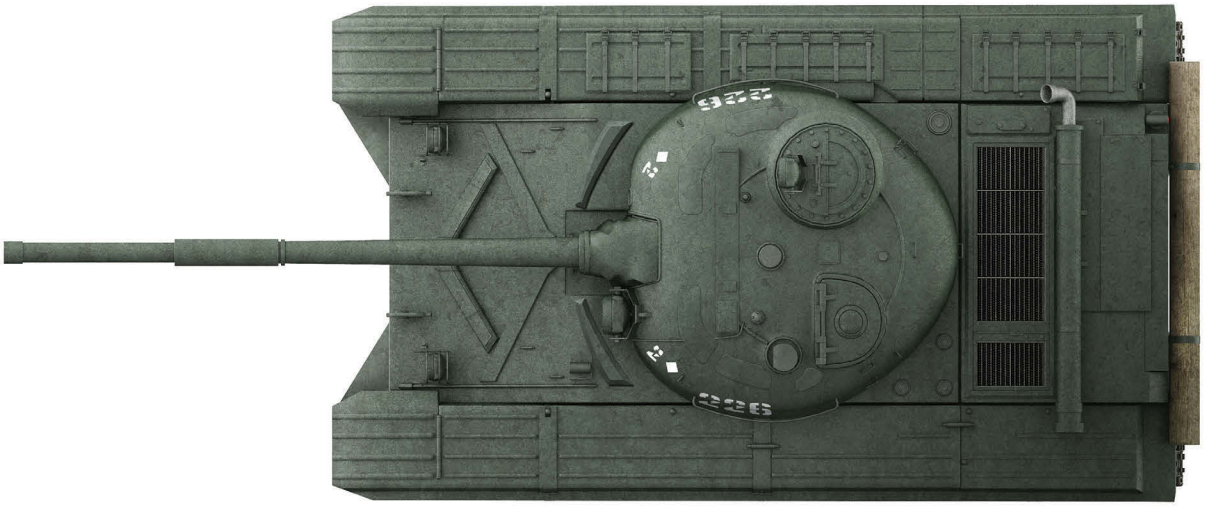
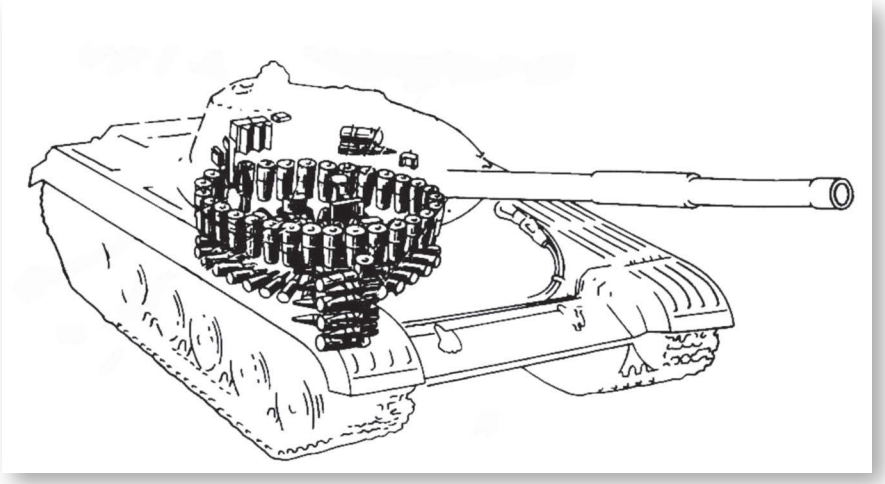


tanks was beginning to appear, including the American M60 and British Chieftain. Soviet tank specialists recognized that the new 100mm D-54T gun could not penetrate the M60 or Chieftain frontally. In 1959, Nizhni-Tagil had already proposed a smoothbore version of the D-54T gun that would permit the use of a fin-stabilized armor-piercing discarding sabot (APFSDS) 115mm projectile. GBTU decided to sponsor this gun for new Soviet medium tanks starting as the 115mm U5-T Molot ("hammer"). Morozov's team was instructed to modify one of the Obiekt 430 prototypes with this weapon in 1959 for trials starting in November 1960 as the Obiekt 430A. The U5-T Molot gun used a single-piece round that proved difficult to use within the small confines of the Obiekt 430 turret. As a result, the OKB-9 artillery design bureau in Perm developed the D-68 115mm gun, later called the 2A21, which used a two-piece round consisting of a separate projectile and propellant case. This weapon system was incorporated into a modified version of the Obiekt 430 as the Obiekt 435 prototype. The GBTU believed that the 115mm APFSDS projectile could penetrate the glacis of the M60 at 800 meters and the Chieftain's at 500 meters; it could defeat the turret front of both tanks at 2,800 meters.

The 115mm U5-T gun first went into service with Nizhni-Tagil's new T-62 tank, which was accepted for service in August 1961. The T-62 was basically a T-55 upgraded with the 115mm gun; it offered no improvements in protection or mobility. Morozov's Kharkov team argued that it was still inferior to the new NATO tanks such as the M60 and Chieftain. In particular, the T-62 could be penetrated by NATO tanks at ranges beyond those at which its 115mm gun could penetrate them. Soviet assessments were that the NATO 105mm gun could penetrate the T-62 glacis and turret front at 3,000 meters. A later assessment by VNII-100 Transmash in Leningrad confirmed this using their computer modeling program. In this assessment, the baseline T-55 was given a value of "1.0," which was then compared to the T-62 and NATO tanks as shown in the chart below.

Aside from the numerous requirement changes for the armament, the automotive trials of the various Obiekt 430 prototypes revealed the need

The Obiekt 435 was the first attempt to mount the 115mm gun in the Obiekt 430. However, the Obiekt 432 incorporated many changes before going into serial production.



The T-64 had 28 rounds of its ammunition placed in a 6EhTs-10 hydromechanical autoloader, with the remaining nine rounds stowed elsewhere in the fighting compartment.

for further work on the powerplant and drive-train. On February 17, 1961 the Council of Ministers terminated the Obiekt 430 programs and authorized the construction of five Obiekt 432 tanks in 1962 and a further test batch of 20 in 1963. The Obiekt 432 incorporated numerous automotive changes as well as the D-68 115mm gun. Two prototypes were completed in September-October 1962 and sent to the Kubinka proving ground for tests. On October 22, 1962 a special demonstration was held at Kubinka for senior government and military leaders, including Nikita Khrushchev. The demonstration of the Obiekt 432 was so impressive that Khrushchev impulsively authorized production even though development trials had not been completed.

Limited production of the Obiekt 432 tank started at Kharkov in October 1963. The plans were to ramp up production at Kharkov to 500 per year by 1965, 700 by 1966 and eventually to 1,800 per year. T-55 and T-62 production would be halted and switched to the Obiekt 432 at the Omsk tank plant by 1965 and at Nizhni-Tagil by 1966 to replace the T-55 and T-62 tanks. The 5TD engine was still proving troublesome in the Obiekt 432, so in 1962 Morozov was ordered to begin adapting a conventional diesel engine to the tank. Even before the D-68 gun had entered production, OKB-9 was assigned to develop a more powerful tank gun that could penetrate the new NATO tanks frontally at a range of over 2,000 meters. As a result, the D-68 115mm gun was regarded as only an interim solution to be used on an "establishment lot" of Obiekt 432 tanks.

The advanced armor of the Obiekt 432 was developed by the Moscow affiliate of VNII-100, the tank industry's main research center in Leningrad, and later known as Transmash. They worked in conjunction with the research institute of the steel industry, TsNII-48 (now NII Stali). The main NATO threat was judged to be shaped-charge warheads, both tank-fired HEAT projectiles and the new guided antitank missiles. During the late 1950s,

Comparative Military Technical Co-efficients					
Tank	T-55	T-62	M60A1	Leopard 1A1	Chieftain Mk 1
Country	USSR	USSR	USA	Germany	UK
Combat-Technical Value	1.0	1.35	2.2	2.2	3.0

a variety of laminate armors were studied to protect the glacis plate. These usually consisted of a basic outer and inner layer of rolled homogenous steel armor with a sandwich of materials in between. Range testing found that when a shaped-charge warhead detonated against a laminate armor array, the hypersonic jet of metal particles was gradually bent and diverted as it passed through the various layers. The materials that were studied included aluminum, titanium, plastics, and ceramics. Ultimately, VNII settled on a laminate of 80mm of steel armor on the outside followed by two 52mm layers of fiberglass (*steklotekstol*) and a final 20mm layer of steel.

Turret protection was more complex, since it had to protect against both kinetic energy projectiles such as HVAP (high velocity armor piercing) and APFSDS as well as shaped-charge attacks. Although laminates could be used, VNII-100 found two other solutions to be more attractive in terms of weight and volume. The simplest was to create a thick cavity in the front of the turret that was filled with aluminum. This combination began with an outside layer of 50mm of steel followed by 330mm of aluminum, and finally the innermost layer of 100mm of cast steel. As in the case of the fiberglass/steel laminate, this significantly degraded the penetration of shaped-charge warheads. However, a more promising technique tested in early 1961 was to suspend a matrix of ceramic balls (*Ultrafarfor*) in the cavity. This type of "combination armor" was created by constructing a matrix of ceramic balls in the casting mold with the balls suspended by means of metal wires and springs in their proper position. The armor steel was then poured into the mold, enveloping the ceramic ball matrix. During test firing, the ceramic combination armor provided complete protection against 85mm and 100mm HEAT projectiles and 115mm APFSDS projectiles, as well as 75 percent protection from 115mm HEAT projectiles. This satisfied the Obiekt 432 survivability requirement and this solution was eventually chosen for the original Obiekt 432 turret armor, even though it weighed about 250kg more than the aluminum combination armor.

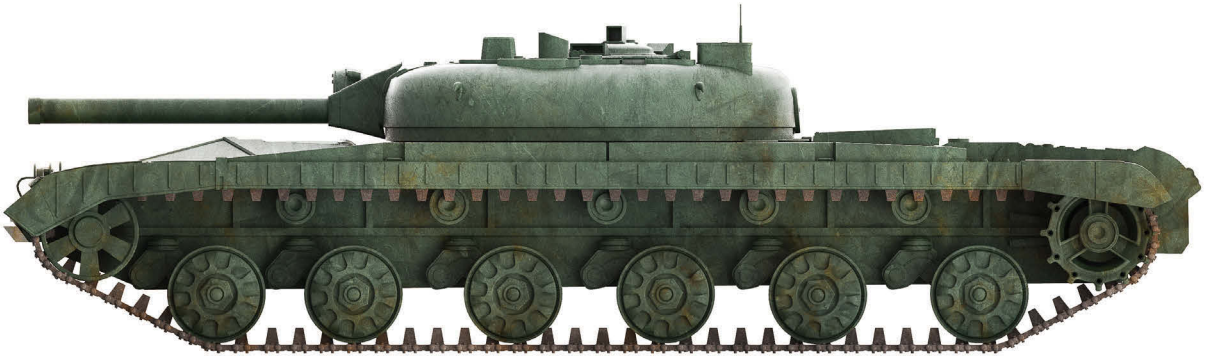
It was later discovered that in some cases the molten steel melted the wire and spring of the matrix, causing the balls to congregate at the bottom of the mold instead of being spaced evenly in the front. There was no practical way to determine when this had happened, so the ceramic ball composite armor was dropped in favor of other types of fillings, starting with aluminum.

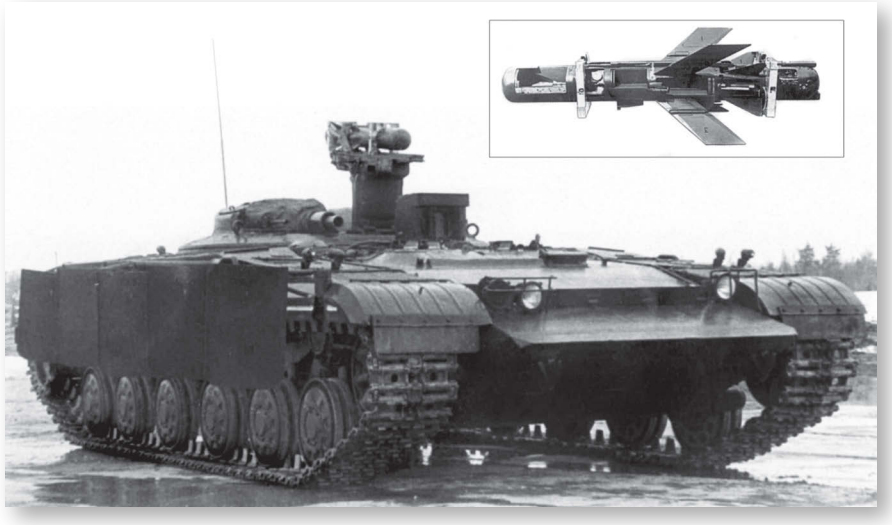
Soviet research facilities studied other novel protective techniques during this period as well. One concept was to use a fence of metal bars arranged like Venetian blinds, codenamed Zont (umbrella). This could detonate the shaped-charge warhead away from the tank, but it also sometimes caused the warhead to fail when it separated the nose fuze of the projectile from the warhead before it detonated. These metal screens (*ekrani*) were effective for the front and front corners of the tank, but too heavy for the sides. Instead,

B

OBIEKT 775, KUBINKA NIIBT POLIGON, MOSCOW REGION, 1964

The Chelyabink Obiekt 775 was the most radical rocket tank of the 1960s, using a modified version of the T-64 suspension but with a special "kneeling" suspension to further reduce the tank height. It was one of "Khrushchev's Follies," a concept at the bleeding edge of technology and not practical in either technical or tactical terms. To minimize the size, the tank was limited to a two-man crew in the turret, with the driver sitting in a rotating seat and the commander doubling as the gunner. The smoothbore weapon could fire either the Rubin guided antitank missile or the Bur high-explosive rocket projectile.





The Obiekt 287 was a Kirov factory missile-tank based on a modified T-64 chassis. The basic version used a retractable launcher for the Taifun guided antitank missile, as in the inset photo showing the missile with its fins deployed. Two small turrets on either side were armed with the 73mm 2A25 Kopye rocket gun that fired a projectile based on the RPG-7 antitank rocket.

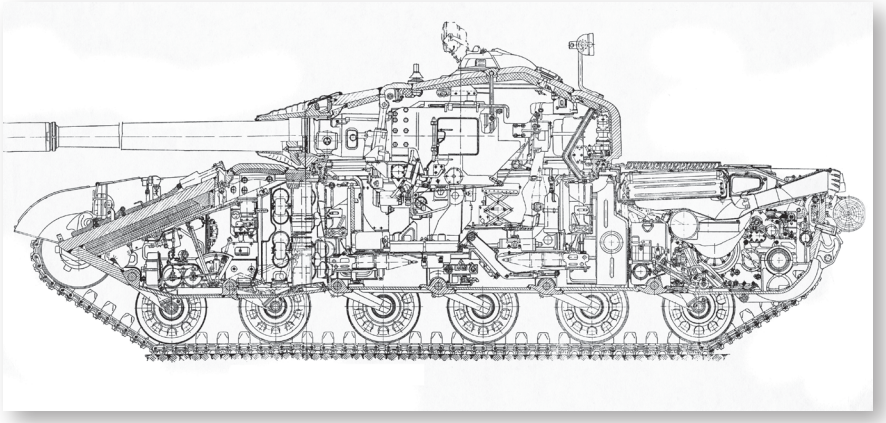
simple, light-weight flipper panels, nicknamed "Eloshka" (Christmas tree), were developed using sheets of resin-impregnated fabric reinforced with thin steel plates. These folded against the tank during travel and then were flipped out in combat to shield the hull sides from frontal attack by shaped-charge warheads. The ZEhT-1 Zontik protective screen set was accepted for service in 1964 but only the Eloshka flipper panels went into production for the T-64. They were first fitted to the T-64A in 1966, and retrofitted to the T-64 in 1967.

THE ROCKET TANK DISTRACTION

Soviet premier Nikita Khrushchev became entranced by missile and rocket weapons in the late 1950s, an off-shoot of the space enthusiasms of the day. In the military field, he became convinced that missiles would revolutionize land warfare. Antitank missiles would make heavy tanks obsolete; rockets and missiles would replace conventional artillery guns. As a result of Khrushchev's encouragement, an extensive array of tank-mounted missile programs were started by a government decree of July 4, 1959.

Besides the guided-missile programs, there was also interest in rocket-powered projectiles as an alternative to conventional tank projectiles. Soviet intelligence was aware that such programs were underway elsewhere, such as the French 142mm ACRA and the US 152mm Shillelagh tube-fired tank missiles. This program was nicknamed Project RS (*raketniy sniard*: rocket projectile) in many of the design bureaus. Several of these programs involved the Obiekt 432, though many of the schemes went little further than paper design studies.

The Obiekt 431 was a tank destroyer based on the Obiekt 430, but armed with about 20 ECh-155 Delfin (dolphin) guided missiles mounted in a fixed casemate in place of the turret. The Delfin project was assigned to the TsNII-58 research institute led by the well-known artillery designer V. G. Grabin. However, the institute failed to overcome the challenging problems of missile guidance and the Delfin program was eventually abandoned before a prototype Obiekt 431 was constructed. In 1962,



A cross-sectional drawing of the T-64 medium tank.

the VNII-100 tank research center in Leningrad proposed a version of the Obiekt 432 tank, but armed with a rocket gun capable of firing a tube-launched 152mm guided missile as well as unguided rockets based on the same design. The weapon was mounted in a conventional turret and the tank could carry 12 guided rounds and 28 unguided rockets. The Chelyabinsk Tractor Plant began a similar scheme designated as Obiekt 772. Two different missiles were proposed, the 9M15 Taifun (typhoon) and the Lotos (lotus) developed by TsKB-14 KBP in Tula. Both versions used a conventional turret fitted with a tubular launcher, fed by an autoloader with ten Lotos missiles or 15 Taifun missiles. Since there were so few missiles, there was a coaxial gun armed with 73mm antitank rockets, a gun-launched version of the RPG-7 infantry antitank rocket. One of the last of these projects was the Astra tank, started in March 1963, which fired the 152mm Rubin guided missile. None of these tanks proceeded beyond design studies.

Besides these projects undertaken in conjunction with Kharkov, two other programs were handed off to other design bureaus, but using components of the Obiekt 432 tank. Obiekt 287 was managed by the Leningrad Kirov plant, and was similar to the Obiekt 431. It used an Obiekt 432 hull with a new weapons module in place of the turret. In the center was a retractable

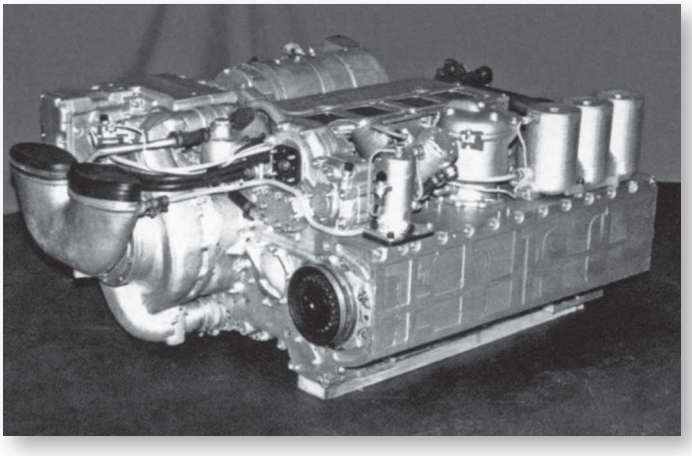
One of the serial-production T-64 tanks armed with the 115mm D-68TS gun. Aside from the gun, these tanks can be distinguished from later variants by the armored splash strip on the glacis plate and the early stowage configuration without antiaircraft machine gun and with the OPVT snorkel stowed on the rear engine deck.

A T-64 on summer exercise prepares to disembark from a GSP tracked ferry.

missile launcher. Several missiles were proposed for this design, including the OKB- 16 Tochmash 3M11 Falanga (NATO: AT-2 Swatter) and the 9M15 Taifun. On either side of the missile launchers were small turrets armed with a 73mm antitank rocket gun. Field trials of the Obiekt 287 started in 1965. The Kirov factory also developed the Obiekt 288 with a multi-weapon missile system with gas-turbine propulsion. In the center was a module that contained a retractable launcher for a rail-fired antitank missile and on either side of the turret was a gun-tube launcher for the 125mm Rubin guided missile. This weapon system was never completed, but the Kirov factory built a powerplant demonstrator of the Obiekt 288 that used a GTD-350 gas-turbine engine.

The most radical of the rocket tanks was the Obiekt 775, a competitor to the Kharkov Astra program, undertaken by the Chelyabinsk Tractor Plant. This used a modified version of the Obiekt 432 propulsion and running gear. However, the Obiekt 775 had only a two-man crew, with the driver in the turret. The special external hydraulic suspension allowed the tank to "crouch down" to minimize overall height. The armament system was the Rubin weapon system developed by V. I. Shavyrin's KBM in Kolomna. This consisted of 125mm guided Rubin missiles and the Bur unguided rocket, with the tank's magazines carrying 14 Rubin and 17 Bur rounds. The Obiekt 780 back-up program was started at the Chelyabinsk Tractor Factory but with a more conventional three-man crew; this did not progress to prototype stage.

The early problems of the T-64 centered around the reliability of its 5TD two-stroke, opposed-piston engine. This style of engine was dubbed the "Suitcase" (*Chemodan*) due to its shape. This shows one of the upgraded 5TDF engines.

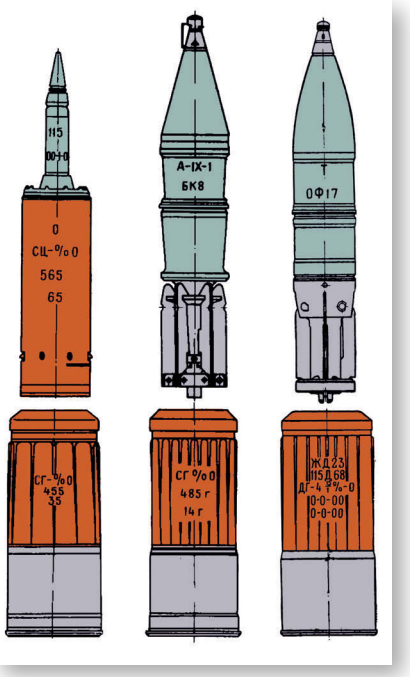


By the time that the Obiekt 287 and Obiekt 775 had reached the trials stage, Khrushchev had been ousted. The army was not especially enthusiastic about these missile tanks since they carried few missiles and were not useful in traditional tank missions requiring high-explosive

firepower. The only type to reach production was the IT-1 tank destroyer, based on the T-62 tank, and fitted with a retractable launcher for the 3M7 Drakon antitank missile. There were some suggestions to mount the IT-1 turret on the Obiekt 432 hull, but this was stillborn. Both the Obiekt 287 and Obiekt 775 missile tanks were canceled formally on February 16, 1968 when attention turned to the idea of using a new 125mm guided projectile from the normal D-81T gun.

T-64 INITIAL PRODUCTION

Production of the Obiekt 432 totaled 218 tanks by the end of 1964. These tanks, still considered experimental, were first deployed for troop trials with the 41st Guards Tank Division headquartered at Chugyevo near Kharkov. Troop trials of the Obiekt 432 ended in February–March 1964, with scathing complaints about the engine durability and other issues. There had been a continual string of improvements to the Obiekt 432 during its short production cycle, and Moscow instructed the Kharkov tank plant to prepare a set of definitive production tanks for another round of trials to see if the fixes did in fact solve the problems. Additional troop trials using a new batch of Obiekt 432 tanks manufactured in June–July 1964 were conducted by the 37th Guards Tank Division of the Belorussian Military District. The nine tanks were operated from September 14 to November 28, and engine and suspension problems lingered. Tests of the autoloader in 1965 found that it malfunctioned nearly a third of the time.

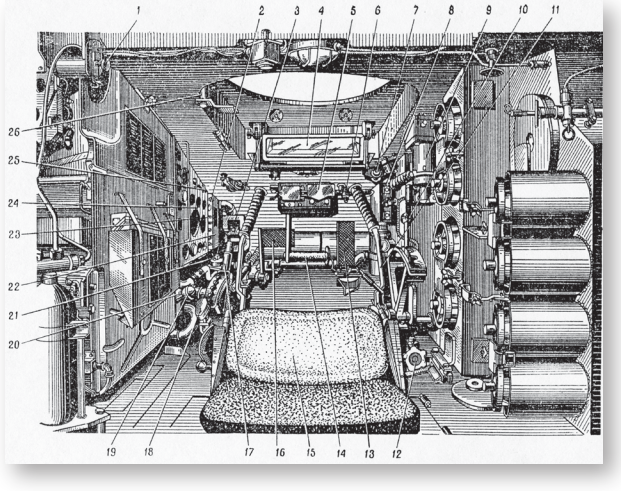


This illustration shows the three basic rounds of the 115mm D-68TS gun of the T-64. From left to right they are the 3VBM1 round with 3BM5 AAPFSDS projectile; 3VBK4 round with 3BK8 HEAT projectile; and the 3VOF18 round with 3OF18 HE-Frag projectile.

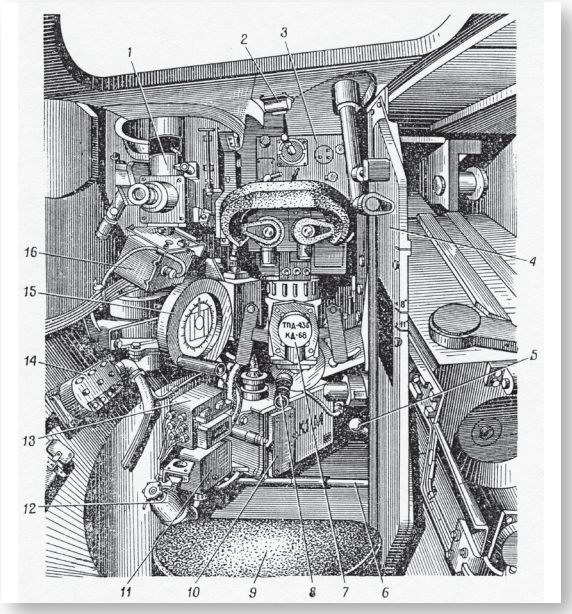
The technical problems with the Obiekt 432 tank were exacerbated by the tendency of the Kharkov bureau to provide overly optimistic assessments of when the Obiekt 432 would be ready for service. In the wake of Khrushchev's ousting in October 1964, there was considerable turmoil in the Kremlin as Khrushchev's allies were replaced by officials loyal to the new premier, Leonid Brezhnev. The political turmoil in the Kremlin rippled through the defense industry as the various tank plants tried to win political support for their new tank programs. As a Nizhni-Tagil history later recalled:

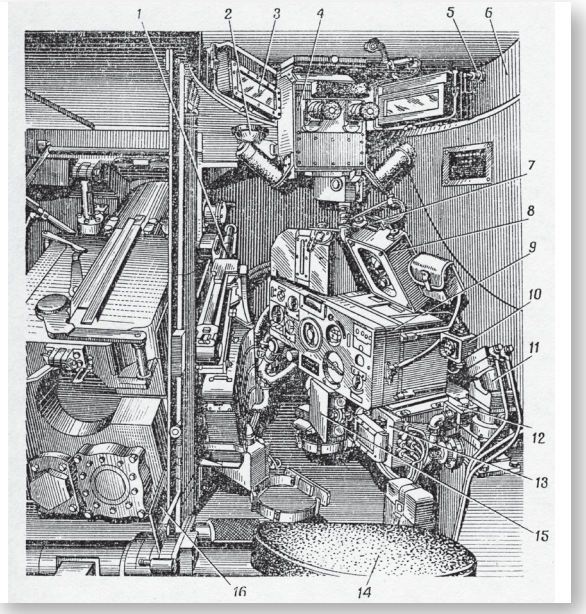
> Over the course of seventy years of the existence of the Soviet Union there was never any opposition to [the Communist Party's] supreme right to rule, but there were continuous and vicious fights among the Party "clans" based on the territorial principle. Correspondingly there were "Ukrainian", "Leningrad", "Moscow" and then finally "Ural" clans.

The tank plants in Nizhni-Tagil and Leningrad, along with their political supporters, began sniping at the Kharkov Obiekt 432, echoing the numerous complaints coming from the army.



A view of the driver's station of the T-64 from the operators' manual.





LEFT
A view of the gunner's station of the T-64 from the operators' manual.

RIGHT
A view of the commander's station of the T-64 from the operators' manual.

One reason that there was so much acrimony over the new tank was its cost. As of January 1, 1968, a T-62 tank took 5,855 man-hours to build, but the T-64 required 22,564 man-hours, four times as many. In terms of cost, the price for a T-62 in 1973 was 62,000 rubles compared with 143,000 for the T-64A, more than double the price.

The situation with the Obiekt 432 tank had become so dire that on April 16, 1965, the Central Committee of the Communist Party held a special session in Moscow to discuss the issue along with representatives of the tank industry. Heading the meeting was leader of the defense industries Dmitri Ustinov. He began the discussion by noting that the Obiekt 432 program, after the nuclear missile program, was the top priority of the ministry of defense. He berated the Kharkov staff:

> We had faith and followed the path to the new engine, even though it was fraught with many shortcomings. We kept faith and belief that these shortcomings would be corrected when it entered series production. But now more than three years have passed, and the matter has practically not moved away from that original point. At the present time, the (Obiekt 432) cannot be placed into production and cannot be accepted for service with the troops.

The government insisted that Kharkov reach a durability goal of 150 engine hours by 1965, and 300 engine hours and 3,000 km by 1966; the ultimate goal was 500 engine hours and 5,000 km. In 1964, the average engine lifespan was 89 hours. In the first half of 1965 it rose to 115, but in the second half it fell to 85. In spite of the small size of the operating fleet, 62 engines failed in service in 1965 and had to be replaced. By early 1966, the durability had increased to only 100 engine hours and 2,325km. By comparison, Soviet experts assessed the contemporary American M60A1 to have a durability of 6,400km. Even as late as 1967, 35 percent of the engines deployed with army units had failed and the average operating engine lifespan had increased to only 212 hours. One of the main culprits was the

air cleaner system, and this was subject to repeated redesign. An army report in early 1969 concluded that of the 808 T-64 tanks in service in 1967–68, 390 had suffered engine failures, of which 288 had occurred sooner than the basic 200-hour warranty.

The continuing problems with the 5TDF engine led to additional pressure to examine other powerplant options. The Omsk plant was instructed to adapt the V-46 diesel engine as the Obiekt 436, while Trashutin's bureau at the Chelyabinsk Tractor Factory was assigned to adapt its V-36 diesel engine to the Obiekt 432. Ustinov was an advocate of the gas-turbine engine for tanks, and he instructed Kharkov to adapt the GTD-3TL turbine engine to the Obiekt 432 as the Obiekt 289. There was some recognition that Morozov had not been allotted enough staff, and on January 5, 1966, the various branches of the KB-60 design bureau at the Kharkov tank plant were consolidated under Morozov's control. It was renamed as OKB-60 and later as KhKBM (Kharkov Industrial Design Bureau).

The political fights over the fate of the T-64 became especially vicious. A major center of opposition to the Obiekt 432 was the army's GBTU tank directorate, and especially its assistant director, Gen A. M. Sych. In the autumn of 1966, Sych was relieved from his role over alleged security violations in what was widely believed to be a KGB sting operation orchestrated by Ustinov. The head of the GBTU, Lt Gen N. P. Belyanchev, was also relieved and replaced by Gen P. P. Poluboyarov. With Sych out of the way, the Obiekt 432 was accepted for Soviet Army service on December 30, 1966 as the T-64 medium tank. In April 1967, Morozov and several other officials were awarded the Lenin Prize for their work on the T-64. In fact, the tank's problems were far from over.

In August 1967, the Kremlin ordered that all tank factories would switch to the production of the T-64 starting in 1968. The Kirov factory in Leningrad was to begin in 1968, followed by Nizhni-Tagil, Omsk, and Chelyabinsk in 1970. The Krasnoye Sormovo shipyard in Gorkiy was assigned as a war-mobilization factory for the T-64. The standardization scheme continually slipped due to the technical problems with the T-64. In May 1969, the plan to start T-64A production at Omsk was pushed back from 1972 to 1974. The Kremlin allowed two of the tank plants to begin work on alternative engines for the T-64, the Obiekt 439 with V-45 diesel engine at Nizhni Tagil and the Obiekt 219 with the GTD-1000T gas turbine in Leningrad.

Total production of the basic T-64 tank in 1964–68 was 1,192 tanks. Due to the lingering problems with these tanks, their use was confined to the Belorussian Military District and the Carpathian Military District in western Ukraine. None were ever deployed with the premier tank units of the GSVG (*Gruppa sovetskikh voysk v Germanii*: GSFG: Group of Soviet Forces Germany).

The difficulties that the T-64 encountered on entering army service were not only due to its technical problems, but also to the army's failure to recognize the need for more thorough training due to the greater complexity of the T-64. One later study concluded that the crew workload in the T-64 was about 2.2 times greater than that of the older T-62. This was in part due to its greater complexity, but also a consequence of its use of a three-man crew instead of the previous four-man crew. One Soviet engineer climbing

The Israeli use of improved 105mm long-rod penetrators in their APFSDS ammunition in the 1982 war, and comparable NATO upgrades, prompted the Soviet Army to add a 40mm armor face plate to the glacis of the T-64A during periodic rebuilding, as seen on this example of a rebuilt T-64A at the Central Armed Forces Museum in Moscow.

into a T-64 for the first time considered the controls to be more complicated than in a jet fighter. But Soviet jet fighters were piloted by officers who underwent several years of training; the T-64 was typically commanded by a conscript NCO who left the army after two years after having become marginally acquainted with all the intricacies of the new tank. A senior Soviet tank engineer later remarked that "the T-64 was a lot like a soldier wearing polished boots; they were light, comfortable and pretty – but only for a parade. In combat it was better to have ordinary felt boots."

From 1977 to 1981, the T-64 tanks remaining in service underwent a capital rebuilding program that modernized their radio sets to current standards, added the Brod deep-wading system, and added a number of stowage features from the T-64A. These rebuilt T-64 tanks were designated as T-64R (R = *remontniy*; rebuilt).

THE T-64A TANK (OBIEKT 434)

As mentioned earlier, the 115mm D-68 tank gun was recognized to be a stopgap for the T-64 until a more powerful gun was ready. At least three guns were considered for this requirement, starting in June 1961. Two 125mm smoothbore guns, the D-81 and D-85, were developed along with the rifled 122mm D-83. The D-81 offered an initial muzzle velocity of 1,745 meters per second compared with 2,000 meters per second for the D-85. However, the D-85 proved to be too complicated and expensive for serial production and remained in development into the late 1960s. The rifled D-83 also was abandoned. Development of the Obiekt 434 was

C

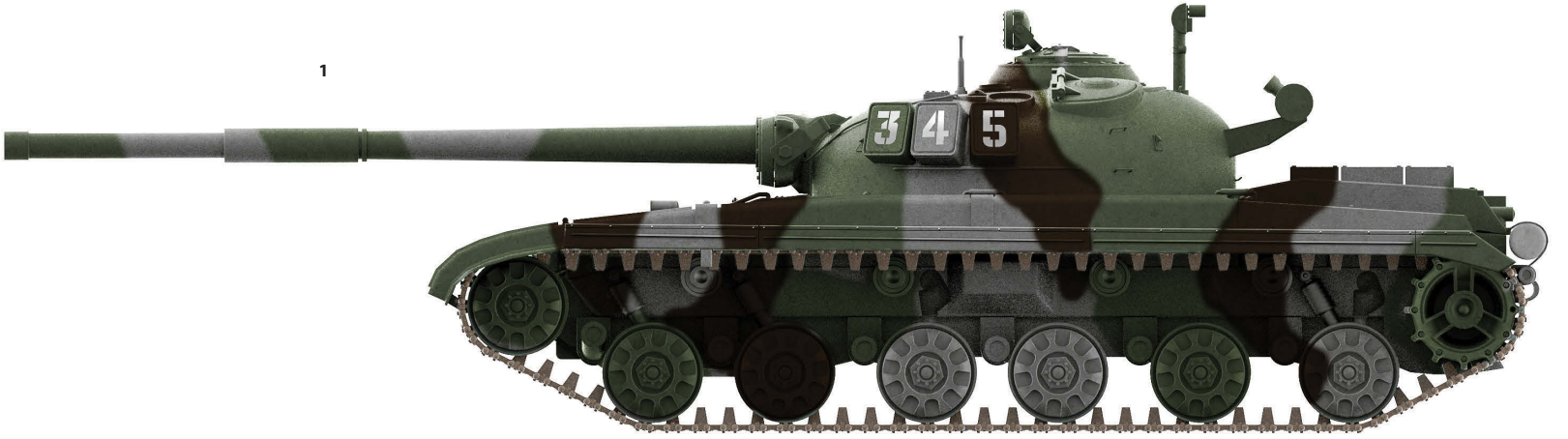
1: T-64R STANDARD TANK (OBIEKT 432R), 1970S CAMOUFLAGE PATTERN

The Soviet Army did not regularly use pattern-painted camouflage during most of the Cold War, though there was a standard engineer doctrine on the subject and booklets were published showing suggested patterns. Camouflage painting was sometimes undertaken during large wargames as part of the exercise, with the work usually being done by dedicated engineer teams with an associated truck-mobile POS (*Polevoy okrasochnoy stanitsa*: Field Painting Station). The colors depended on the local conditions. The desert pattern was supposed to consist of brown, tan, and gray. The winter pattern was either overall white or rolling bands of white over the usual army green. Temperate camouflage was usually a pattern of gray and black over the usual army green, as seen here.

2: T-64A MODEL 1981 (OBIEKT 434 OBR. 1981 G.), 1980S CAMOUFLAGE PATTERN

In the late 1980s, the Soviet Army began to adopt a factory applied three-color disruptive camouflage scheme closely resembling the US Army MERDC scheme. The colors consisted of the usual dark green (KhS-5146), with a pattern of gray-yellow (*sero-zheltiy* KhS-5146) with black crow's feet (*cherniy* KhS-5146). These schemes remained common through the 1990s at both Russian and Ukrainian tank plants and were not formally terminated in Russia until April 2013 with the decision to switch back to the normal overall dark-green scheme.

1



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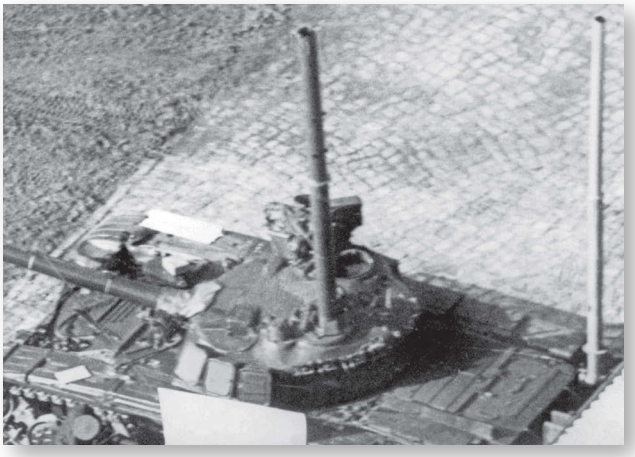


The T-64A was fitted with an OPVT deep-wading snorkel system for crossing rivers. This included two snorkel tubes, one above the gunner's hatch and the other for the engine at the rear right corner. This is a relatively early-production T-64A, with the OPVT stowage still on the rear engine deck and without the rear turret stowage.

authorized in August 1962. The program included the refinement of the new 125mm gun by OKB-9 in Perm along with new fire controls, a new autoloader, and numerous sub-systems.

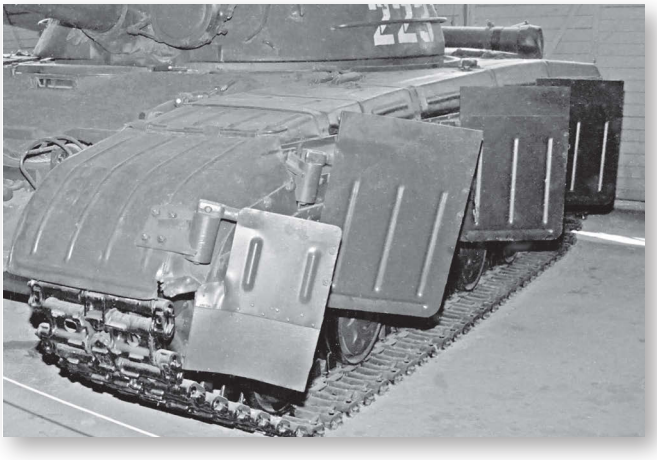
The first batch of Obiekt 434 tanks was delivered for trials in the summer of 1966. In May 1968, the Kremlin approved the Obiekt 434 for service as the T-64A. This led to the first serial production order for the type. Of the 425 T-64 tanks ordered from Kharkov in 1968, 12 were the new T-64A, while the rest were the baseline T-64. The first serial production batch of tanks was delivered in January 1969 and was subjected to factory trials. The winter trials showed an average engine durability of 435 hours and endurance of 8,235km; these were still short of the objective but substantially better than a few years before. Initial troop testing of the first batch of the T-64A in August–September 1969 appeared to be favorable, with the five tanks covering 5,000 to 7,200km.

Clan Wars Intensify

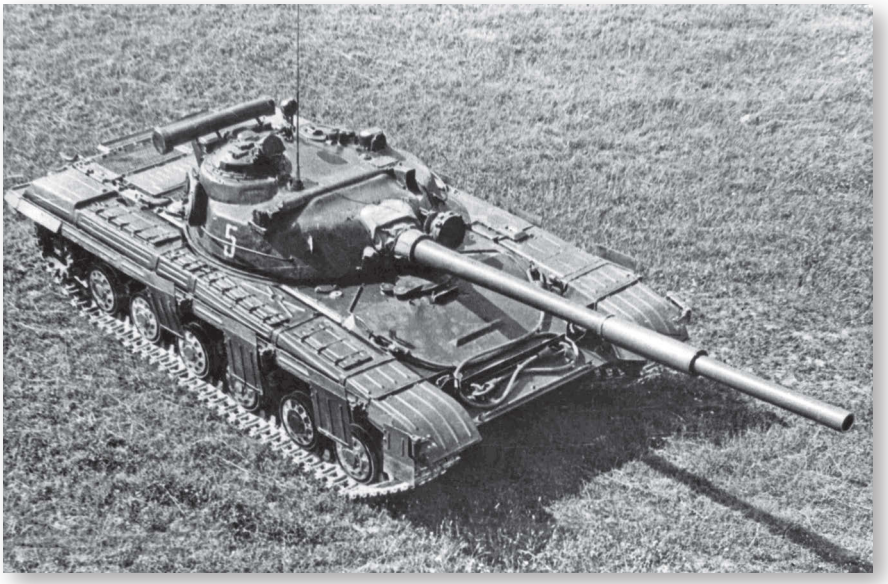
By the end of the 1960s, the first prototypes of the rival Obiekt 439 had been completed at Nizhni-Tagil with the V-45 diesel engine, and range testing began in the autumn of 1970. Nizhni-Tagil exceeded Moscow's orders. Besides the V-45 engine, they replaced the suspension and autoloader with their own designs from the aborted Obiekt 167 (T-62B), arguing that this would help cure the other reliability flaws with the T-64A. The design was so different from the Obiekt 439 concept that it was redesignated as the Obiekt 172; it would eventually emerge as the T-72. In December 1969, the GBTU reported that comparative trials between series production T-64A tanks and two Obiekt 172 prototypes had been conducted and that the diesel powerplant was so promising that further work should be conducted.

Many elements of the army, continually frustrated by the poor performance of the T-64, began to side with the rebels from Nizhni-Tagil. The most vocal supporter of the Obiekt 172 was Maj Gen Yuriy Ryabov, the deputy to the new Chief of Tank Troops, Marshal A. K. Babazhanyan, who had been appointed in May 1969. Ryabov was very influential in the industry since he had been assistant chief of the GBTU tank administration. Minister of Defense Andrei Grechko came to side with the Obiekt 172 as well. Regardless of the differences in opinions in the army and industry, the key supporter of the T-64A remained the powerful secretary of the Central Committee, Dmitriy Ustinov, and it was with his blessing that the T-64A remained in production.

The only element of the ZEhT-1 Zontik protective screen set regularly fitted to the T-64A was the "Eloshka" (Christmas tree). This was a set of folding panels that flipped out in combat to shield the sides from frontal attack by shaped-charge warheads.



By 1970, the T-64A finally seemed to be reaching maturity. In the autumn



While this appears to be an ordinary T-64A, it is in fact one of the Obiekt 439 prototypes with the V-45 diesel engine that still retained the original T-64A suspension.

of 1970, the Kiev Military District conducted an exercise by the 42nd Tank Division, fully equipped with the T-64 tank. Of the 330 tanks taking part in the maneuvers, only 22 broke down and these were quickly repaired. This exercise was conducted as part of an effort to start deploying the T-64 in the Group of Soviet Forces Germany. A January 1971 report noted that T-64 reliability had improved three-fold based on trial results in 1969–70.

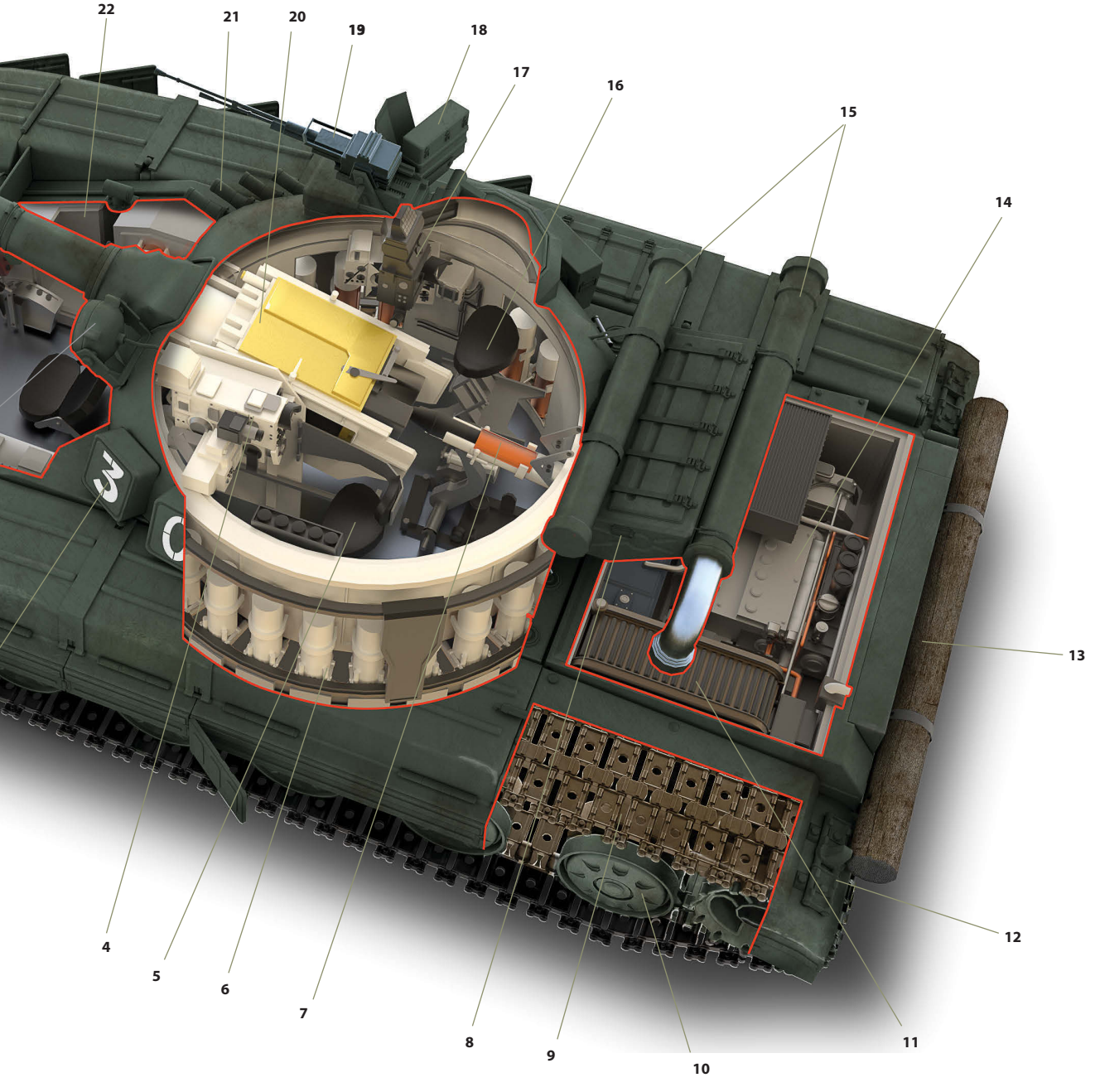
In May 1971, Ryabov completed the 1972 tank production plan. He recommended an initial production of 150 Obiekt 172 tanks at Nizhni-Tagil, though the final decision was left to the ministry of defense. Problems lingered with the T-64A, and in frustration, the army was diverting about 80 percent of the new production T-64A tanks into storage or training units instead of into the tank divisions. The crisis came to a head on July 8, 1971 when the Kremlin dispatched a delegation of its top defense leaders to Kharkov including Dmitriy Ustinov, defense minister Andrey Grechko, and the head of the ministry of defense industries S. A. Zverev. By this time,

A T64A from the 1975 production series fitted with the new 12.7mm Utes remote-control machine-gun station on the commander's cupola and the added rear turret stowage bin; the machine gun is not fitted here. As was often the case, tanks left off the Eloshka flipper panels during peacetime maneuvers to avoid damage or loss.

Technical Data	
Length (m)	9.295
Width (m)	3.539
Height (top of turret, m)	2.17
Main gun (mm)	125mm D-81TM (2A46M-1)
AA machine gun	12.7mm NVST
Autoloader	6EhTs40
Main gun rounds total	36
Rounds in autoloader	28
Gun stabilizer	2Eh42
Rangefinder-sight	1G42
Missile fire control	1A33
Night sight	TPN-1-49-23
Searchlight	Luna L-4A
Combat weight (metric tons)	42.4
Engine	5TDF two-cycle opposing-piston diesel
Horsepower	700
Internal fuel (liters)	730
External fuel (liters)	540
Aux fuel (liters)	370
Max range w/o aux fuel (km)	600
Max range w/aux fuel (km)	700
Power/weight ratio (HP/T)	16.5
Ground pressure (kg/cm2)	0.92
Top speed (km/h)	60.5

KEY

1. Luna L-4A infrared searchlight
2. Eloshka flipper panels
3. Turret stowage bin
4. 1G42 gunner's sight
5. Gunner's station
6. Autoloader carousel
7. 6EhTs40 autoloader
8. Rear turret stowage bin
9. Track
10. Road wheel
11. Engine air cleaner
12. Spare track link
13. Unditching beam
14. 5TDF diesel engine
15. Deep wading tubes
16. Commander's station
17. Commander's day/night sight
18. 12.7mm ammunition box
19. 12.7mm NVST
20. Main gun breech
21. Tucha smoke mortars
22. Fuel cells
23. 125mm D-81TM (2A46M-1)

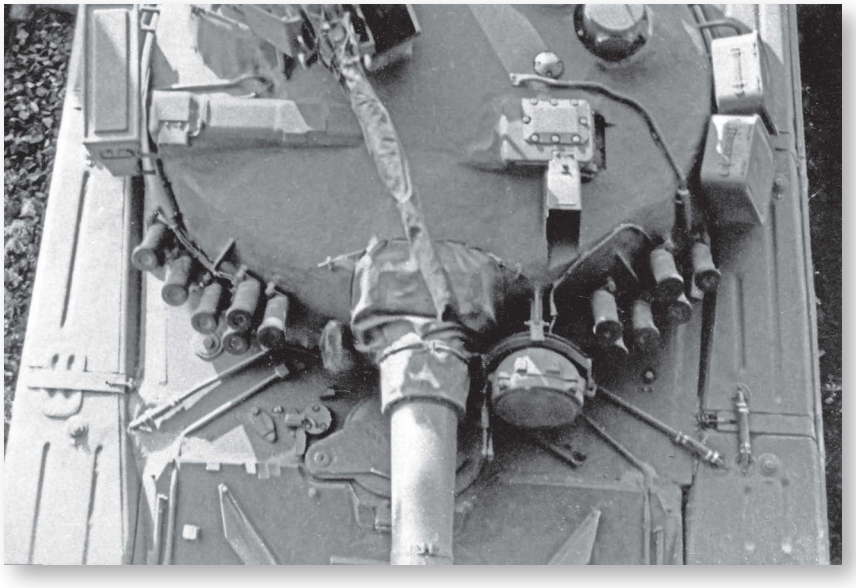


even Ustinov was growing wary of the T-64. Grechko immediately got to the point:

> I came here at the orders of [Soviet premier] Leonid Brezhnev who has suffered a lot over the T-64A tank ... I have always protected Morozov and his tank, but now, based on the reports from the army units, I have been disappointed. The factory boys have told me many times that they have fixed the tank and the engine, but their information has never panned out ... Acceptance of tanks from the factory has been halted ... We have not requested any supernatural requirements for the tank: we need an engine with a durability of 300 engine hours, and with 3,000 kilometers. Testing of the latest batch, per the report of our people, did not go well. Therefore I have had to take the T-64A out of the western divisions. By August 1, 1971 the T-64 tanks will be retired to the combat training park.

The threat to end T-64A production was clearly understood, but Morozov counted on the quality control improvements beginning to take hold. The next round of testing went very well for the T-64A. Fifteen new production tanks were put through their paces in June–November 1971 and averaged 480 engine hours and 9,800km. Grechko retracted his threat, and in November 1971, the MOP was instructed to begin plans to ramp up T-64A production to 900–1,000 tanks by 1975. Production orders for 1972 were 1,242 tanks, including 916 T-64A and 326 T-64AK command tanks. By 1972, the engine life had increased to 700 engine hours according to state bench tests.

Although the T-64A had redeemed itself, its two rivals had prospered during the crisis. The T-72 had won strong support in the army by promising to offer a degree of reliability not found in the T-64A. It was accepted for Soviet Army service in August 1973 and started production at Nizhni-Tagil in November 1973. Furthermore, the industry had been planning to use the aborted Obiekt 439 as the basis for a Warsaw Pact tank suitable for production in Poland and Czechoslovakia to replace the outdated T-55. The T-72 was selected for this role and entered production in Poland in 1985 and later in Czechoslovakia. A number of Leningrad politicians were pushing for the Obiekt 219 (T-80), but the army resisted its adoption as there were concerns over the excessive fuel consumption of its gas-turbine engine.



Starting in 1979, the T-64A tanks were fitted with the new Type 902A Tucha-1 (Cloud) smoke-grenade launchers on the front of the turret.

The possibility that three significantly different tanks might be in production simultaneously for the Soviet Army met with

The Eloshka side flipper panels were replaced starting in 1980 with a new side-skirt made of resin-impregnated fabric. This permitted the addition of a frame behind the skirt for attaching Kontakt-5 ERA bricks at a later date. This is a relatively early T-64A retrofitted with the skirts, but it lacks the Utes remote machine-gun mount introduced during the 1972 production run. The white cross marking painted over the top of the tank was usually associated with Soviet offensive operations such as Berlin in 1945, Hungary in 1956, and Czechoslovakia in 1968, but it was also used in peacetime to distinguish opposing forces during wargames.

growing resistance by both the army and the industry, since it was appreciated that this would create a logistics and training nightmare. In June 1973, the defense section of the Central Committee of the Communist Party released the "Voronin Report on Possible Tank Production Options." It suggested four basic options. Option 1 was to produce the T-64A at all plants except Leningrad; in the event of war, all plants would produce the T-64A. Option 2 was for all factories to produce the T-72 except for Leningrad with the T-80; in wartime all plants would produce the T-72. Option 3 would continue T-64A production at Kharkov, T-72 production at Nizhni-Tagil, Chelyabinsk, Nizhni-Novgorod, and Omsk and the T-80 in Leningrad; in the event of war, Kharkov, Leningrad, and Nizhni-Novgorod would produce the T-64A and the others the T-72. The Voronin Report labeled these three options as unacceptable. Option 4 was to produce the T-64A at all Soviet factories but one and the T-72 in Poland and Czechoslovakia and at Nizhni-Tagil; in wartime three Soviet factories would produce the T-64A, and two Soviet factories and the Warsaw Pact countries would produce the T-72. The report also recommended that the Omsk plant should convert to T-80 production.

The T-64B Sosna had a variety of upgrades to the turret, including the Kobra guidance antenna in front of the commander's cupola, the deletion of the right-side optics previously used by the TPD-2 optical rangefinder, and the enlarged 1G42 gunner's sight on the left side of the turret roof. The 2A46-2 gun was fitted with a thermal shroud around the barrel to reduce warpage.

The Obiekt 219 might have been retired as another failed experiment but for the death of defense minister Andrei Grechko in April 1976 and the appointment of Dmitriy Ustinov in his place. Ustinov had soured on the T-64A after all the disputes in the late 1960s and he had been one of the most ardent advocates of the conversion to gas-turbine propulsion since the mid-1960s, starting with army helicopters. The Obiekt 219 had become one of his pet projects and it had

LEFT
The T-64B was fitted with a GTN-12 antenna box in front of the commander's cupola to guide the Kobra missile. (Bartosz Musialowicz)

RIGHT
The T-64B underwent continual upgrades during production. This example, manufactured in October 1977, is preserved at the Ukrainian Victory museum in Kiev. It was upgraded with the additional plate of armor on the glacis and the later pattern side skirts. (Bartosz Musialowicz)

the strong support of the Leningrad politician Grigoriy Romanov. Romanov was a rising political star, widely viewed as a future Soviet premier, and he took over Ustinov's old military industry post with the Central Committee in 1983. As a result, on August 6, 1976, the Obiekt 219 was suddenly accepted for production under the army designation of T-80. Because of this, three Soviet tanks were in production by the late 1970s: the T-64 at Kharkov, the T-72 at Nizhni-Tagil, and the T-80 at Leningrad and Omsk, all with similar combat capabilities in terms of firepower, protection, and mobility, but all with different suspensions, powerplants, and many other sub-components. One later Russian study labeled these decisions as "a crime against the state." By this stage, these tanks were no longer referred to as medium tanks (*sredniy tank*) but as standard tanks (*osovnoy tank*), the Russian equivalent of NATO's "main battle tank."

Improving the T-64A

The T-64A underwent numerous small changes to its subsystems during its production run; this description covers only the most significant, as there were dozens of smaller mechanical changes. The baseline tanks were fitted with the TPD-2-1 (1G15-1) rangefinder, and in 1971 this was replaced by the upgraded TPD-2-49 (1G15-2). Externally, the OPVT deep-wading snorkel for river crossing was moved from the engine deck to a stowage mount on

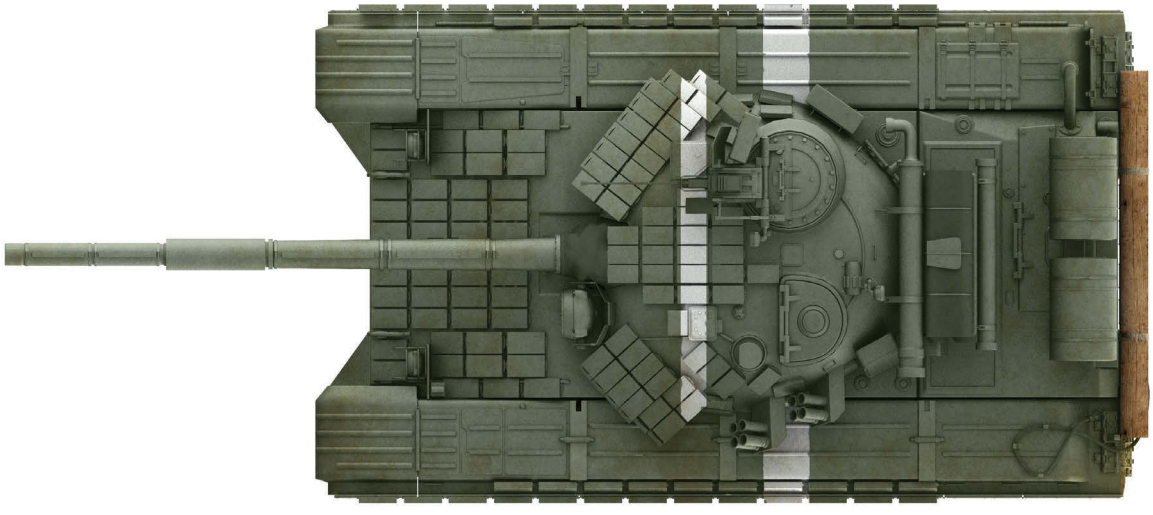
E

T-64BV MODEL 1985 (OBIEKT 447A OBR. 1985 G.), GROUP OF SOVIET FORCES GERMANY, 1989

During summer wargames, it was common for tanks assigned to the opposing forces (*uslovnogo protivnika*) to have distinctive markings, in this case a white band over the turret and hull. This was usually applied with temporary paint and the application was not particularly precise. During exercises, it was common for divisions to assign temporary tactical markings to tanks and other vehicles to assist military police in managing convoys. Usually each division would have a geometric symbol, in this case a triangle, and within it would be a set of numbers, in this case "180" for one of the regiments, and another symbol for the battalion or company below this. Some Soviet tank units began the practice of marking external fuel tanks on the T-64 to avoid crews putting oil in fuel tanks or vice versa. In this case, the three left-side fuel tanks are marked TOPLIVO (fuel) while the oil tank on the right rear corner is marked MASLO. On new tanks, the side skirts were left in their natural black color with metal fittings in army green as seen here; this was often over-painted during periodic upgrades.

180
2

ТОПЛИВО

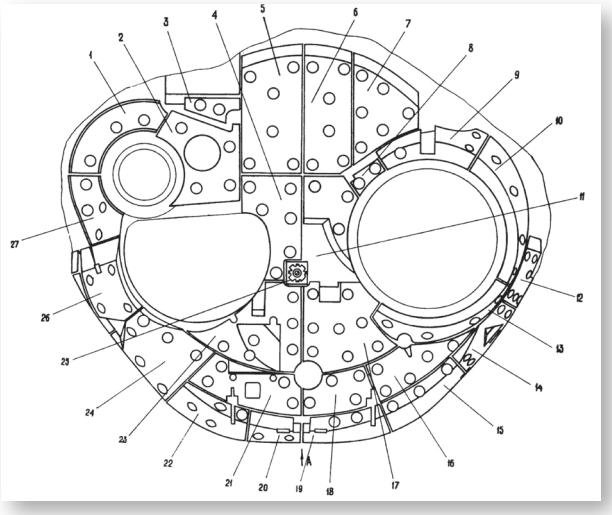


A good example of a T-64A of the post-1972 production series with the Utes remote machine-gun mount and retrofitted side skirts. The bin on the right side of the turret, seen here with the "bort" (side) tactical number 155, was added to stow the bits associated with the OPVT snorkel.

the turret and a new bin was later added on the turret for its associated parts. In January 1973, the new T-64A tanks were fitted with the *Ehlement* dozer blade under the bow for self-emplacement and hard points were added to permit the mounting of the KTM-6 mine rakes. One of the most visible changes in 1973 was the fitting of a remote-control 12.7mm Utes (cliff) antiaircraft machine gun mounting in place of the previous commander's cupola. This system had been in the works for some years in response to the growing threat of NATO helicopters armed with antitank missiles. Another alternative, an external mount for three Strela-3 (SA-14 Gremlin) antiaircraft missiles on the rear of the turret, was tested but rejected.

During range trials of the steel/aluminum combination turret armor on the T-64A, it was found that after a non-penetrating hit, voids and weak zones would be created in the aluminum filler. In 1973–74, the turret composite armor was improved through the use of a corundum filler in place of the previous aluminum filler, sometimes called Kombination K (K= *korundoviy napolnitel*). Corundum is a crystalline form of aluminum oxide and this was probably used in a pelletized form. This armor upgrade was retrofitted to older T-64A tanks during capital rebuilding.

The NATO deployment of enhanced radiation weapons led the Soviet Army to increase the antiradiation protection on the T-64B by use of an appliqué of resin-impregnated lead panels to the roof of the tank, as shown in this instruction drawing of the package.



Starting in November 1974, the T-64A tanks were fitted with the improved D-81TM (2A46-1) gun with an improved stabilizer. In August 1975 a thermal jacket was added to the gun tube to reduce barrel warping. In January 1979, the tanks began to be fitted with the new Type 902A Tucha-1 (Cloud) smoke grenade launchers on the front of the turret. These fired a 3D6 smoke grenade about 200 to 350 meters in front of the tank, creating a smoke screen. In January 1980, the side *Eloshka* "flipper" panels were gradually retired and replaced with new composite resin/fabric skirts. The final batch of tanks manufactured in January 1981 absorbed many of the changes intended for the subsequent T-64B, including the new turret with improved

armor, laser rangefinder and other features. It should be noted that many of these changes were retroactively fitted to earlier versions of the T-64A as they underwent capital rebuilding at Soviet rebuilding plants. The most important of these was Factory No. 115 (115-m BTRZ) in Kharkov that served as the lead plant for these projects. Total production of the T-64A was about 4,600 tanks plus another 780 T-64AK command tanks.

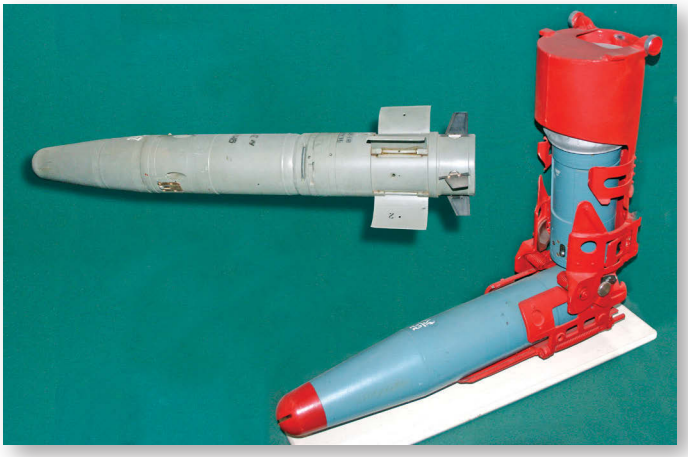
LEFT
The Kontakt-5 reactive armor package began to be fitted to T-64A and T-64B tanks in 1984. Some tanks such as this T-64B had the mounting lugs fitted but not the actual "bricks." While this tank might seem to be a T-64B1 due to the lack of the GTN-12 antenna box in front of the commander's cupola, the antenna was sometimes left off for security reasons.

RIGHT
A T-64B on maneuvers in the early 1990s with the mounting racks for the Kontakt-1 ERA on the turret, but without the "bricks."

THE T-64B SOSNA MISSILE TANK

By the late 1960s, army tank specialists had come to regard missile-armed tanks as simply another one of Khrushchev's "hare-brained schemes." There was a revival of interest in 1968 due to the US Army development of the 152mm Shillelagh missile for the MBT-70, M60A2, and M551 Sheridan tanks. The Rubin missile developed in the early 1960s could be fired through a 125mm tube, so there was recognition that it might be possible to fire a missile through the existing D-81TS gun. This was more attractive than the previous missile tank idea that required a dedicated launch system. In Russian, these systems are usually called KUB (*Kompleks upravlyayemogo*

When the Kontakt-1 ERA was fitted to the T-64B, it required the rearrangement of other external equipment including the Tucha smoke-grenade loaders from the front of the turret to the sides, as seen here. This tank is also fitted with the antiradiation cladding on the turret roof and rear sides. The Cyrillic writing on the side is "Toplivo" (fuel).



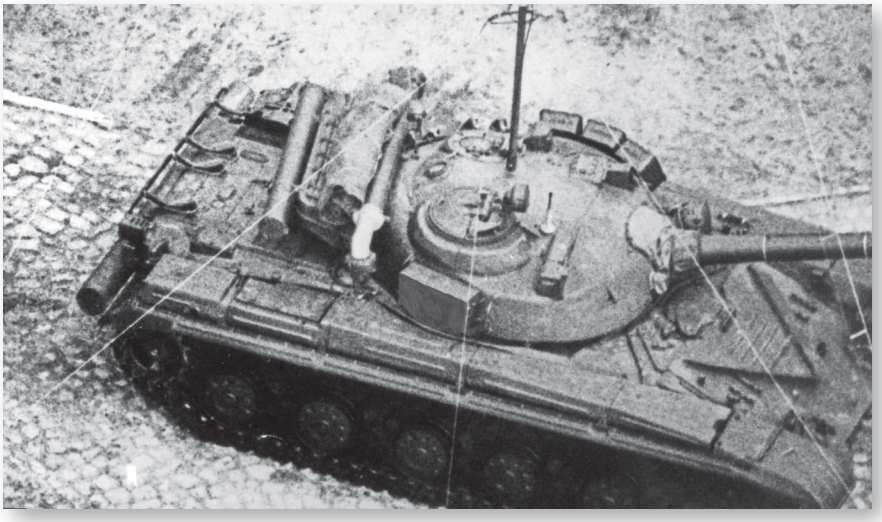
The new Kobra missile had to be designed to fit within the T-64B's 6EhTs-40 autoloader. The missile was placed in the autoloader in two parts, as seen to the right, and the two sections were clipped together during the autoloading process, as seen above to the left.

vooruzhenie: guided weapon system) to distinguish them from PTUR (*Protivo-tankovoe upravlyayemaya raketa*: antitank guided missile).

In May 1968, the Kremlin approved development of tube-fired guided missiles for the Obiekt 434 using either the Kobra (cobra) or Gyurza (viper) systems. The radio-guided 9K112 Kobra system was developed by A. E. Nudelman's OKB-16 Tochmash in Moscow, while the infrared-guided Gyurza system was developed by S. P. Nepobidimiy's KBM in Kolomna. The Gyurza program was short-lived since it quickly became apparent that heat-seeking guidance was unsuited to land combat due to the large number of distracting heat sources on the battlefield; it was canceled on January 14, 1971. The Kobra missile was based on an earlier radio-guided missile codenamed Gvozd (nail). The early version of the missile proved unstable, since the launch was often accompanied by such heavy clouds of dust that the command signal was interrupted. The renamed Kobra avoided this by using a smaller booster charge to push the missile out of the gun tube, followed by a more powerful sustainer rocket motor once the missile was free of the tank. The Kobra program faced numerous challenges beyond its complicated guidance system. To begin with, the army insisted that the missile had to be compatible with the T-64A autoloader, implying a very small missile. Tochmash came up with the idea of building the missile in two parts corresponding to the normal 125mm ammunition. The aft section contained a small booster motor to kick the missile out of the gun, while the front half contained the main rocket sustainer motor. The rear section also contained much of the guidance system, while the front section also contained the HEAT warhead. The two sections were automatically clipped together when the autoloader fed the round into the gun breech. The tank required a special guidance package to control the missile, including the GTN-12 antenna box that was mounted on the turret roof in front of the commander's cupola. A prototype T-64A fitted with the Kobra system was delivered in September 1969.

While development of the Kobra system was taking place, a variety of improvements had been proposed for the T-64A tank. On August 12, 1973, the government approved the start of the Obiekt 447 Sosna (pine tree) program to incorporate the Kobra system into an improved T-64A along with the 1A33 Ob fire-control system. The 1A33 Ob system substituted a laser rangefinder for the coincidence rangefinder used in the earlier tanks. In addition, it included a ballistic computer, wind sensor, cant sensor, and other

Work on the T-65 PST "Future Medium Tank" began in 1971. This is a model of Kharkov"s contender, the T-74 (Obiekt 450), which was armed with a main gun in an external mount, with the crew deep in the hull. (Wojciech Luczak)



The T-64AK command tank had a mounting for the telescoping antenna of the R-130 long-range radio set. This antenna could only be used when stationary, since it had to be kept erect using special guide lines.

upgrades, which improved its accuracy about 1.6 times over the system in the T-64A. To accommodate the Kobra missile, the modified 6EhTs 40 autoloader was developed. The Sosna package was accepted for service on September 3, 1976 as the T-64B. The advanced electronics in the T-64B led to a sharp price increase, from 194,000 rubles for the T-64A to 318,000 rubles for the T-64B gun-missile tank. Due to the high cost of the Kobra missile, the Sosna was manufactured in two configurations: the T-64B with the Kobra missile system, and the T-64B1 (Obiekt 437A) without the Kobra system.

When first deployed in Soviet tank regiments, the usual practice was to assign the T-64B to special "sniper" companies. Within each tank battalion, two companies would remain equipped with the T-64A, while a third company would receive the new T-64B "sniper tank."

As in the case of the T-64A, there was continual upgrading of the T-64B during production. In January 1979, the Type 902B Tucha smoke-grenade launcher was added. At the end of 1979, a package of improvements was incorporated into the new production tanks including the 2Eh42 gun stabilizer, upgraded 1A33-1 fire-control system, upgraded 9K112-1 Kobra missile system, modified autoloader, and the new side skirts. A variety of more powerful guns were considered for the T-64B. These included the 130mm LP-36E rifled gun (2A50) and the 125mm D-91T Anker (2A66) smoothbore gun, but none of these types were accepted for serial production.

The only combat engineering kit regularly fitted to the T-64A was the KMT-6 mine rakes, which were used to plow away shallow antitank mines.

The T-64 family included an integral nuclear protective system (PAZ: *Protivo-atomovnaya zaschita*), which included both active systems, such as warning systems and air filtration, as well as passive systems, such as antiradiation liners in the crew compartment. Due to US Army plans to field enhanced-radiation warheads (neutron bombs) on some of its artillery systems in the mid-1970s, an upgraded PAZ system was

The T-64A was tested with the KMT-5 mine-clearing rollers, but these did not become standard. This example is preserved at the Toliatti museum, along with many other examples of combat-engineer equipment. (Jim Kinnear)

developed between 1974 and 1976. Since the interior of the tank would not permit a thicker antiradiation lining, a new external system of resin/lead appliqué panels (*PAZ nakladka*) was designed. This was fitted to the roofs of T-64B tanks starting in 1983.

Another upgrade in this time period was prompted by tests of new Israeli 105mm APFSDS projectiles captured by Syrian troops during the 1982 Lebanon War. These rounds could penetrate the existing glacis armor of the T-64A, and so a program was begun to add an additional 40mm face plate on top of the existing glacis plate. This was done during periodic rebuilding of the tanks.

The Soviet Union had been developing explosive reactive armor (ERA) since the late 1940s to supplement the existing armor, but it was the Israeli deployment of Blazer ERA during the 1982 Lebanon War that triggered its actual deployment. In Russian, ERA is called DZ (*dynamicheskaya zashchita*: dynamic protection). NII Stali (Scientific Research Institute of the Steel Industry) conducted an accelerated research program on the Kontakt-1 system from July 1982 to January 1983 based on previous Soviet studies, and it was accepted for service in 1985. The Kontakt-1 DZ consisted of steel boxes containing a 4S20 tile inside. The tile consisted of a steel plate backed by a sheet of plastic explosive. The Kontakt boxes were steeply angled relative to the expected impact of an enemy shaped-charge warhead. When the shaped-charge warhead struck a Kontakt box, it detonated the explosive, which propelled the steel plate up into the shaped-charge's penetrating stream. The hypersonic penetrating stream was severely eroded by the interaction with the plate. According to NII Stali, Kontakt-1 degraded the penetration of a 125mm missile warhead by 86 percent when it struck at 65 degrees, and 72 percent when it struck at 45 degrees.

Among the specialized engineering vehicles based on the T-64 chassis was the MDK-3 entrenching vehicle. (Jim Kinnear)

Initially, Soviet tanks were prepared for the appliqué with special attachment bolts on the glacis plate and turret as well as special frame mounts for the side; the actual explosive bricks were not fitted until some years later. When fitted with reactive armor, the T-64A and T-64B tanks were designated as T-64AV and T-64BV (V= *vzryvniy*: explosive).

One of the final upgrades to the T-64 was the adoption of the improved 6TD-1 engine, based on the earlier 5TDF diesel but with an additional set of cylinders. This was accepted for service on December 21, 1983 as the T-64AM and T-64BM. Total production of the T-64B family was about 4,200 tanks plus another 1,200 T-64B1.

A single example of the BREM-64 armored recovery vehicle was built on the T-64A chassis, but limitations of its engine led to its abandonment before series production.

T-64 FOLLOW-ON: THE T-74 PST

In 1971, the Soviet tank industry began work on a new tank design intended to replace the T-64 after 1981. Three tank plants offered designs for the T-65 PST (*Perspektivniy sredniy tank*: Future Medium Tank). Several guns were proposed for the tank, including high-powered 125mm guns, 130mm rifled guns, and 152mm guns. Leningrad proposed the turbine-powered Obiekt 225 and diesel-powered Obiekt 226; Chelyabinsk offered its Obiekt 780. Both were turreted designs with new composite armor. Kharkov offered its Obiekt 450, unofficially dubbed the T-74. The Obiekt 450 was the most radical of the designs, placing the crew in the hull and mounting the gun overhead. Over the next several years, all three design bureaus refined their offerings, the Leningrad project evolving into the Obiekt 258, the Chelyabinsk into the Obiekt 785, and Kharkov adding the Obiekt 480, which had a more conventional turret than the Obiekt 450 and was fitted with the Drozd active protection system. Following Ustinov's appointment as defense minister in 1976, the T-80 was selected for production and the PST program was shelved. Morozov retired in May 1976 and died in 1979. The future tank program was revived in 1983 as the Buntar, later Bokser and Molot tanks.

T-64 COMMAND TANKS

The Soviet Army typically issued special command tanks at battalion level and higher that carried additional radio equipment. The T-64AK was fitted with the R-130 radio, and also had a special mounting for the erection of an 11-meter-high telescoping antenna on the left side of the turret near the gunner's hatch. These command tanks also carried the TNA-3 navigation system and an auxiliary generator to power the radios. The corresponding version of the T-64B was the T-64BK, which also used the R-130 radio set, but had the upgraded TNA-4 navigation system. Consideration was also given to creating a divisional level command-staff tank on the basis of the T-64A as the Obiekt 618 at the Omsk plant. Since the radio equipment took up so much space, the main gun was deleted and a dummy barrel fitted in its place.

The Obiekt 476 was the last gasp of T-64 development prior to the Kharkov plant being forced to switch to T-80U production. Ultimately, its improved turret was absorbed in the new T-80U Olkha program, and its 6TDF engine package was absorbed into Kharkov's T-80UD and later the T-84.

T-64 DERIVATIVES

The Soviet Army typically developed armored recovery vehicles on the basis of all of its medium tanks. The BREM-64 was developed on the T-64A chassis, but it was not accepted for service since the engine was overtaxed in the towing mode and the small engine compartment was not suitable for the usual winch. A small number of T-64 tanks were converted into KhTV (*Khodovoy trenazher vozhdeniya*) driver training tanks at the 115-m BTRZ in Kharkov. As an alternative to the use of OPVT snorkels for river crossing, the Omsk factory built a prototype of the Obiekt 619B tank, which had fittings on the hull to permit the use of detachable pontoons for swimming. This was not accepted for series production.

As was typical with Soviet tank designs, the army chose to use the T-64 chassis as the basis for a variety of specialized support vehicles. The MT-T Eney (Aeneas) heavy multipurpose transporter-tractor was designed at Kharkov using T-64 suspension components, but powered by the V-46-4 diesel engine. This could tow loads of up to 25 tons and carry up to 12 tons of cargo in its rear bed. This went into production in 1979. A variety of specialized engineer vehicles were built on its chassis in the 1980s including the BAT-2 route clearer and the MDK-3 entrenching vehicle. The MT-T

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T-64BM BULAT (OBIEKT 447AM-1), 1ST SEPARATE TANK BRIGADE "LESNYE VOLKI," CHERNIGOV, UKRAINIAN ARMY, 2010

The production series of T-64BM Bulat were deployed in the standard factory-applied three-color scheme standard at Soviet tank plants since the late 1980s and described previously. This particular tank has the usual style of three-digit tactical numbers painted on the explosive reactive armor array. Ukrainian tanks often had a version of the Tryzub (trident) national coat-of-arms painted on the protective cover of the searchlight, as shown in the inset illustrations. The 1st Separate Tank Brigade, nicknamed the Forest Wolves (*Lesnye Volki*) had their own unit shield insignia, worn on parade dress and sometimes on battledress. It is shown in the inset drawing here.

chassis was also used for the original version of the 2S7 Pion 203mm self-propelled gun, but the T-80 chassis was subsequently substituted for the production version. Besides the vehicles developed in Kharkov, the Lugansk Locomotive Factory (LTZ) also used T-64 suspension components as the basis for the PTS-2 amphibious tracked transporter and PMM-2M self-propelled ferry.

T-64 GLOSSARY

Industrial designation	Army designation	Notes
Obiekt 429AM	MT-T	Multi-purpose transporter on T-64 chassis
Obiekt 430	-	Prototype with 100mm D-54TS gun
Obiekt 430A	-	Obiekt 430M with 115mm U-5T gun
Obiekt 430M	-	Improved prototype
Obiekt 430U	-	Project with 122mm D-25TS gun
Obiekt 431		Turretless tank destroyer project with Delfin ATGM
Obiekt 432	T-64	Production tank with 115mm D-68TS gun
Obiekt 432R	T-64R	T-64 modernized to T-64A standards (*remontniy*)
Obiekt 432T	-	Prototype with GTD-3TL turbine engine
Obiekt 434M	T-64AM	Rebuilt T-64A with 6TDF engine, ceramic armor upgrade
Obiekt 435	-	Obiekt 430 test-bed with 115mm D-68 gun
Obiekt 437	-	Prototype with 125mm D-85TS gun
Obiekt 437A	T-64B1	Reduced-cost version of T-72B without Kobra
Obiekt 438	-	Prototype with V-45 diesel
Obiekt 439	-	Planned reserve/mobilization version with V-45 diesel; later Obiekt 172
Obiekt 445	-	Prototype with V-45 diesel
Obiekt 446	T-64AK	Command tank version of T-64A
Obiekt 446B	T-64BK	Command tank version of T-64B
Obiekt 447	T-64A-2M	Prototype with Kobra, other upgrades
Obiekt 447A	T-64BM	Rebuilt T-64B with 6TDF engine
Obiekt 447AM-1	T-64BM Bulat	Ukrainian upgrade in 1990s; aka T-64U
Obiekt 447AM-2	T-64BM-2	Ukrainian upgrade with Ros fire controls, other upgrades
Obiekt 450	T-74	Proposed T-64 derivative with external gun for PST requirement
Obiekt 453	MDK-3	Engineer entrenching vehicle based on T-64A chassis
Obiekt 454	BAT-2	Engineer route clearing vehicle on T-64A chassis
Obiekt 476	T-64BM	Prototype with Shtora, Sistema fire controls, new engine
Obiekt 476M	-	Prototype with Shtora, Sistema fire controls, new engine
Obiekt 477	-	Prototype for Buntar, Bokser and Molot future tank
Obiekt 478	T-80UD/T-84	T-80U with 6TD diesel, common turret with T-64BM
Obiekt 480	T-74	Concept with conventional turret with Shtora APS for PST/T-74 requirement

FINAL TRACES OF THE T-64

Ustinov's disenchantment with the T-64 and his growing enthusiasm for turbine tanks led to plans to halt T-64B production at Kharkov and standardize on the T-80 tank. Kharkov had been developing an improved T-64B with substantially improved fire controls and new turret armor as the Obiekt 476. Rather than waste time transferring the features to a new T-80 turret, Moscow decided to merge the new Kharkov turret with the T-80B hull as the Obiekt 219A Olkha (adler), and then to shift Kharkov's

production from the T-64B to the T-80. Under this scheme, the design bureau at the Leningrad Kirov factory was responsible for the overall program while Kharkov's new chief designer, Nikolai Shomin, was responsible for the turret and armament. The resulting Obiekt 219A was ready for production at Kharkov in the 1982 time-frame, but production was limited to a relatively small number of tanks for trials due to the other ongoing technology initiatives including new tube-fired missiles and reactive armor. These were eventually incorporated into the Obiekt 219AS that was accepted for Soviet Army service in 1985 as the T-80U (U= *usovershenstvovanniy*: improved), which went into series production at Omsk in 1987. Although the T-80U was undoubtedly the best Soviet tank of its day, it came at a high price. A VNII Transmash study concluded that the T-80U was about

T-64 Comparative Technical Data

	T-64	T-64A	T-64B	T-64BV
Service introduction	1967	1969	1976	1985
Length (m)	8.95	9.225	9.225	9.295
Width (m)	3.415	3.415	3.415	3.539
Height (top of turret, m)	2.15	2.17	2.17	2.17
Max range w/o aux fuel (km)	650	600	600	600
Max range w/aux fuel (km)	n/a	700	700	700
Glacis armor (mm)	80+105+20	80+105+20	80+105+20	120+105+40
Glacis armor equivalent vs HEAT (mm)	450	450	450	900
Glacis armor equivalent vs APFSDS (mm)	410	410	410	530
Turret front armor (mm)	90+150+90	150+150+40	150+150+40	150+150+40
Turret armor equivalent vs HEAT (mm)	450	500	500	950
Turret armor equivalent vs APFSDS (mm)	395	410	410	520
Main gun (mm)	115mm	125mm	125mm	125mm
Gun type	D-68 (2A21)	D-81T (2A26)	D-81TM (2A46-2)	D-81TM (2A46M-1)
AA machine gun	n/a	n/a	12.7mm NVST	12.7mm NVST
Autoloader	6EhTs	6EhTs10	6EhTs40	6EhTs40
Main gun rounds total	37	37	36	36
Rounds in autoloader	30	28	28	28
Gun stabilizer	2Eh18	2Eh23	2Eh26M	2Eh42
Rangefinder-sight	TPD-43B	TPD-2-1	1G42	1G42
Missile fire control	n/a	n/a	1A33	1A33
Night sight	TPN-1-432	TPN-43A	TPN-1-49-23	TPN-1-49-23
Searchlight	L-2AG	L-2AG	L-2AGM	L-4A
Combat weight (metric tons)	36.0	38.0	39.0	42.4
Engine	5TDF	5TDF	5TDF	5TDF
Horsepower	700	700	700	700
Internal fuel (liters)	815	738	730	730
External fuel (liters)	330	355k	540	540
Aux fuel (liters)	n/a	370	370	370
Power/weight ratio (HP/T)	19.1	18.4	17.9	16.5
Ground pressure (kg/cm^2)	0.815	0.83	0.84	0.92
Top speed (km/h)	65	60.5	60.5	60.5

The T-64 tank was so secret that it was not displayed in the annual Moscow Victory Day parades until 1985, on the 40th Anniversary of the Great Patriotic War, after it was being replaced by the new T-80A tank. This appearance by a regiment of T-64B1 tanks, attached for the occasion to the 4th Guards Kantemirovskiy Tank Division, was its sole public appearance in the Moscow parades.

10 percent more combat effective than the T-72B, but cost about three times as much: 824,000 rubles compared with only 280,000 rubles.

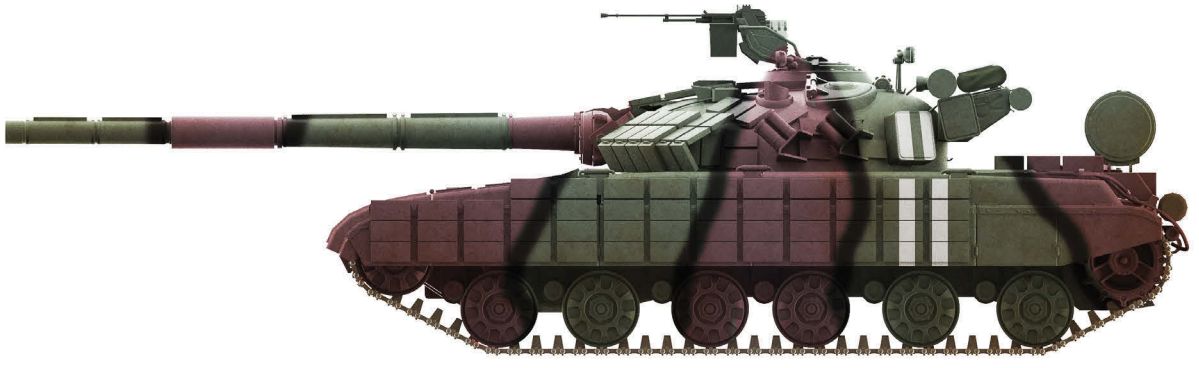
The shortcomings and high cost of the turbine engine in the T-80U led to revived interest in diesel propulsion. During the transition of the Kharkov plant to T-80U production, Kharkov pushed for a diesel-powered version, which was designated as Obiekt 478. It used the 6TD 1,000hp diesel, an enlarged version of the 5TDF engine that had been intended for the improved T-64 (Obiekt 476) and the next-generation T-74. Ustinov was still insistent on the "turbinization" of the army, and so production of the T-64B at Kharkov ended and the facility began to retool to manufacture the T-80U.

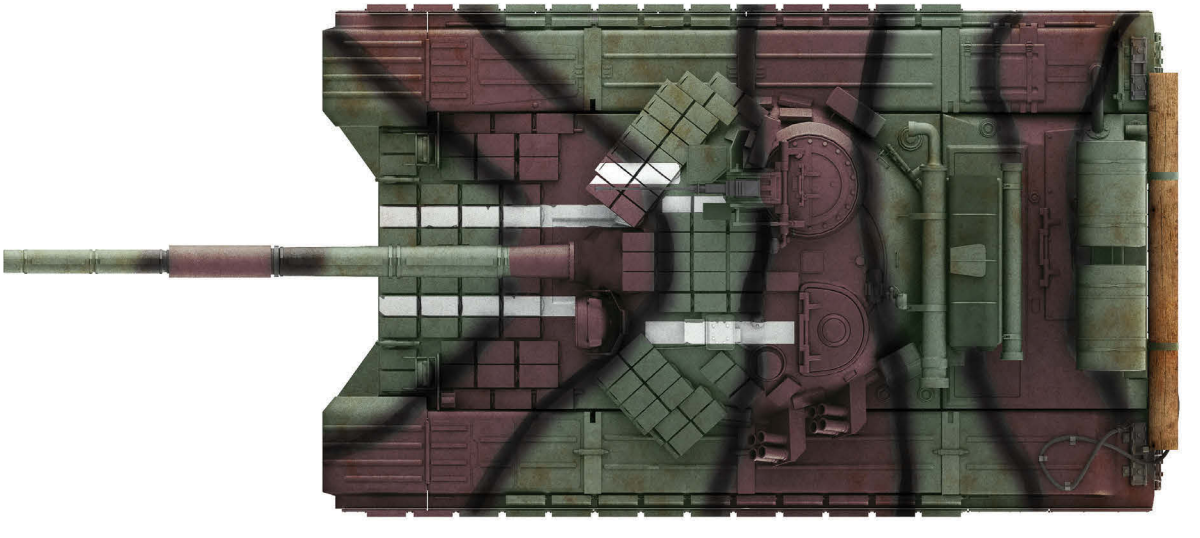
Ustinov's views were not universally shared within the Soviet Army, and a defense ministry study in 1984 concluded that for the next five-year plan, the Soviet Army could purchase 2,500 tanks and 6,000 6TD diesel engines, or 1,500 tanks and 2,000 GTD-1250 turbine engines. Ustinov's death in December 1984 was followed by that of Leningrad party-boss Romanov

G

T-64, UKRAINIAN ARMY, 2014

The Ukrainian Army during the summer of 2014 adopted white identification bands to distinguish its vehicles from those of the DNR separatists. Two styles were in use, a single band or a double band. The bands were applied on the hull front, sides, and rear. In theory, this formed a cross when viewed from overhead, but the complex pattern of reactive armor bricks rendered this impossible. Many Ukrainian tanks received local camouflage painting during the fighting on top of the usual dark-green finish. One of the more common systems is seen here, a dark red-brown edged in black.





The Kharkov plant offered an upgrade package called the Bulat (sword steel), which used the newer Kontakt-5 ERA and other upgrades. A small number were built for the Ukrainian Army in 2005, but widespread upgrades were constrained by the weak defense budget. (KhKBM)

in July 1985, removing the two most prominent supporters of the Leningrad turbine tank and clearing the way for a return to diesel tanks. Production of the T-80U at Kharkov had been painfully slow anyway, and in the event only 45 were built there. Government approval for a diesel-powered T-80U, the Obiekt 478B *Bereza* (birch-tree) was granted on September 2, 1985. Kharkov had hoped to designate the new version as the T-84 in the tradition of T-34, T-54, T-64, T-74, but instead it was designated as T-80UD (*usovershenstvovanniy dieselniy:* improved diesel) to avoid the embarrassment of acknowledging that four similar tanks were in production. Only about 500 were completed prior to the collapse of the Soviet Union. Following the birth of an independent Ukraine, the T-80UD gradually morphed into Kharkov's T-84 and a succession of derivatives such as the current Oplot.

SOVIET ARMY T-64 DEPLOYMENT

According to recent Russian accounts, total production of the T-64 was about 12,000 tanks, though details are lacking. The T-64A was first deployed in the western military districts of the Soviet Union in the 1970s. The intention was to gradually deploy the T-64A with the first-line units facing NATO in the GSFG in Germany and neighboring Warsaw Pact states. The first unit given this task was the 14th Guards Mechanized Division in Juterborg in 1976, reorganized in 1982 as the 32nd Guards Tank Division. NATO first spotted the arrival of the T-64A tank in East Germany in 1976. At first, it was misidentified as the T-72. The T-64A was deployed primarily with the Soviet tank units in the northern regions of East Germany with the 2nd Guards Tank Army, 3rd Shock Army, and 20th Guards Army. Its primacy in the GSFG was short-lived. The new T-80A tank began arriving in Germany in April 1983, initially re-equipping the field armies in the southern sectors of East Germany. However, before the withdrawal of the GSFG, the T-80 had begun to replace the T-64A and T-64B in the three northern field armies as well. The T-64 remained in two divisions and one separate brigade in Germany at the time of the Soviet

T-64 Variants in Service, Atlantic-to-the-Urals, September 1990	
T-64A	1,386
T-64AK	220
T-64B	1,192
T-64BV	159
T-64B1	420
T-64B1K/BV1K	27
T-64R	578
Total	**3,982**

withdrawal. At the time of the collapse of the Soviet Union in 1991, there were 3,982 T-64 tanks in service west of the Urals, with 2,091 in Ukraine.

The new Russian Army decided to standardize on the T-72 and T-80, and so the T-64 force was gradually put in reserve or scrapped. In 2014, the Russian force was estimated to number about 2,000 T-64 tanks in storage and there were additional tanks in the zone east of the Urals. A number of other republics also ended up with modest numbers of T-64 tanks, including Kazakstan and Uzbekistan.

UKRAINIAN MODERNIZATION

Since the new Ukrainian Army had so many T-64 tanks, there were a variety of efforts made to modernize them. There were not enough funds for any significant work until 2005. An upgraded version was proposed as the T-64U Bulat. This introduced the upgraded Kontakt-5 reactive armor found on the T-80UD as well as the upgraded 1A43U fire controls and the uprated 850hp 5TDFM engine; about 75 of these conversions were funded starting in 2005. A more elaborate upgrade was proposed in 2010, the T-64E, which included the upgraded engine 900hp 5TDFE diesel. Other improvements were introduced to the fire-control system to permit use of the Kombat 125mm tube-fire missile, and the tank was fitted with the new Nozh/Duplet active protection system. Another proposal for this project was to incorporate a supplementary 23mm autocannon.

Ukraine attempted to fund some of its development effort by exporting its existing inventory of tanks. A number of schemes were developed at Kharkov to convert the T-64 into other types of combat vehicles. This included the BMPV-64 heavy infantry fighting vehicle, UMR-64 heavy infantry vehicles, and MTU-64 bridge-layer. So far as is known, none of these projects proceeded beyond mock-ups or prototypes. The only known export sale of T-64 tanks by Ukraine was in late 2013 with the sale of 50 T-64BV1 tanks to the Democratic Republic of Congo.

T-64 COMBAT HISTORY

Of all the Soviet tanks of the Cold War era, the T-64 saw the least combat. This was in no small measure due to the total lack of exports. A small number of T-64 tanks were deployed with the Soviet 40th Army to Afghanistan in January 1980, but they were quickly withdrawn as their engines did not perform especially well in the high elevations of the

This illustration compares two of the rival tanks of the late 1970s, the US Army M60A3 and the Soviet T-64B. The turret of the T-64B is substantially smaller than the M60A3 turret.

mountains. The first known combat use of the T-64 occurred after the Soviet collapse during the fighting in the contested borderlands. In June 1992, 18 T-64BV tanks were taken over from the 59th Guards Motor Rifle Division of the Odessa Military District by the local Russian forces of the Pridnestrian Moldovan Republic. During fighting with Moldovan forces in Transnistria, two were knocked out in skirmishes with Moldovan forces around Bendery. One of these was knocked out by an MT-12 Rapira 100mm antitank gun.

The T-64 saw its most extensive combat use during the fighting between the Ukrainian Army and the pro-Russian separatists of the Donetsk People's Republic in the summer of 2014. The Ukrainian Army made extensive use of the T-64BV as well as small numbers of the improved Bulat. The separatist forces also used a variety of T-64 tanks. Ukrainian tank casualties were quite high, with losses in August 2014 of about 280 tanks, mainly T-64BV. These losses were caused by a variety of weapons, principally RPG (rocket-propelled grenades) and artillery strikes using multiple rocket launchers. The T-64BV proved vulnerable to RPGs since their reactive armor was in many cases aged-expired, with the result that it did not offer sufficient protection.

THE T-64 IN RETROSPECT

The T-64 was the most influential Soviet tank design of the Cold War and dominated Soviet, Russian, and Ukrainian tank design until the present day. The decision to concentrate on the T-64 was an inevitable consequence of Khrushchev's rash decisions. His unilateral effort to squash heavy tank

This Ukrainian Army T-64BV was knocked out while fighting with DNR separatists in the town of Ilovaisk on August 22, 2014. It was struck with five RPGs without effect and the tank continued to operate for several minutes. The sixth RPG jammed the autoloader, the seventh injured the turret crew, and the eighth damaged the suspension. Unable to operate, the driver assisted the commander and gunner to safety. (Defense Express via W. Luczak)

designs doomed promising tanks that were being developed at Chelyabinsk and Leningrad in the late 1950s that were closer in capability to NATO tanks such as the M60A1 and Chieftain. The T-64 offered the firepower, armor, and mobility of the NATO tanks, but it came at a price. The T-64 was inevitably quite small to keep its weight under the heavy tank threshold. Its cramped interior limited its modernization potential, as did its lightweight and fragile suspension. Instead of simply abandoning the T-64 paradigm, the Soviet industry trapped itself in the straightjacket of the T-64's small size for a variety of complicated political and economic reasons. As a consequence, Soviet tank design fell behind NATO's in its combat parameters, while at the same time saddling the Soviet Army with three parallel tank programs, each with its own logistics and training burden. Later Soviet assessments of the comparative combat-technical effectiveness in the late 1970s and mid-1980s reflected the stagnation in Soviet tank design, as shown in these charts below. Russia's current T-90 is yet another evolution of the brilliant but flawed T-64 design. The new T-15 Armata, scheduled to enter service in 2015, will be the first break from the T-64 tradition in a half-century.

Comparative Military Technical Co-efficients

Late 1970s	T-72A	T-64A	T-80B	M1 Abrams	Leopard 2A1
Country	USSR	USSR	USSR	USA	Germany
Combat-Technical Value	1.0	1.0	1.15	1.72	1.99

Mid 1980s	T-72B	T-64B	T-80U	Challenger	M1A1 Abrams
Country	USSR	USSR	USSR	UK	USA
Combat-Technical Value	1.0	1.1	1.13	1.31	1.56

FURTHER READING

The best technical history of the T-64 is the Sayenko/Chobitok book, which offers excellent photos and scale plans as well; it does not deal with the politics behind the T-64 program. The third volume in the superb Soviet AFV encyclopedia by Solyakin and others provides a fuller context of T-64 development. The spin-off from these books has been an extensive series of articles on Soviet tank development by the two Pavlov brothers in the monthly magazine *Tekhnika i Vooruzhenie* from 2008 to the present, which has had some excellent material on T-64 development.

Over the past few years, a rich assortment of memoirs have appeared that help explain the "Clan Wars" in the Soviet tank industry during the Cold War years. There are extensive diary accounts from Morozov and Kucherenko, while Kostenko offers a more personal opinion about tank development in his several small books. The controversy has continued in print in recent years, with Uralvagonzavod in Nizhni-Tagil offering their view in several of their books on tank development at the plant. The 2013 volume on the T-72/T-90 has some especially pungent comments on the T-64/T-72 controversy. The Kharkov plant has published a brief overview in several editions, but it provides very little detail compared with its rivals in Nizhni-Tagil.

Tank Manuals

Izdeliye 434: Rukovodstvo po voiskomy remontu (Moscow: GBTU MO, 1974)

Obiekty 434, 437A, i 447A: Katalog detaley i sborochnikh edinits (Moscow: GBTU MO, 1989)

Tank T-64A: Tekhnicheskoe opisanie i instruktsiya po eksplutatsiyi (Moscow: GBTU MO, 1977)

Tank T-64B i T-64B1: Tekhnicheskoe opisanie i instruktsiya po eksplutatsiyi (Moscow: GBTU MO, 1988)

Tekhnicheskoe opisanie tanka T-64 (Moscow: NTV MO, 1968)

Books

Baryatinskiy, Mikhail, *Sovetskie tanki v boyu 1945–2008* (Moscow: Eksmo, 2008)

Baryatinskiy, Mikhail, *Vse tanki SSSR* (Moscow: Eksmo, 2012)

Borisyuk, M. D., (ed.), *Kharkovskoe konstruktorskoe byuro po mashinostroeniyu imeni A.A. Morozova* (Kharkov: IRIS, 1998, 2007)

Chernyshev, V. L., (ed.), *Tanki i lyudi: dnevnik glavnogo konstruktorov Aleksandra Aleksandrovicha Morozova* (Internet: 2006)

Grigoyan, V. A., *Zashchita tankov* (Moscow: Bauman MGTU, 2007)

Karpenko, Aleksandr, *Raketnye tanki* (Moscow: Tekhnika Molodezhi, 2002)

Kostenko, Yuriy P., *Tanki: Vospomonaniya i razmyshleniya* (3 Chasti) (Moscow: ERA, 1996, 1999, 1999)

Kostenko, Yuriy P., *Tanki: Taktika, tekhnika, ekonomika* (Arkhangelsk: Pravda Severa, 2000)

Kostenko, Yuriy P., *Tanki: Chelovek, sreda, mashina* (Arkhangelsk: Pravda Severa, 2001)

Lenskiy, A. G., M. M. Tsybin, *Sovetskie sukhoputnye voyska v posledniy god Soyuza SSR*: *Spravochnik* (St Petersburg: B&K, 2001)

Nikolayevna, V. L., I. G. Zheltov, *Nikolay Kucherenko: Pyatdesyat let v bitve za tanki SSSR* (Moscow: Moskovskie uchebniki, 2009)

Osinski, Albert, *T-64 & T-64A Main Battle Tank* (Lublin: Kagero, 2006)
Sayenko, Maksim, Vasiliy Chobitok, *Osnovnoy boevoy tank T-64* (Moscow: Eksprint, 2002)
Solyakin, A. G., I. G. Zheltov, K. N. Kudryashov, *Otechestvennye bronirovannye mashiny XX vek: Tom 3 1946–1965* (Moscow: Tseykhgauz, 2010)
Suvorov, Sergey, *Tank T-64: Pervenets tankov vtorogo pokoleniya* (Moscow: Tankomaster, 2001)
Ustyantsev, S., D. Kolmakov, *T-72/T-90: Opyt sozdaniya otechestvennykh osnovnykh boevykh tankov* (Nizhni-Tagil: UVZ, 2013)
Zgurets, Sergey, *Oruzhie Ukrainy: Tanki, boevye mashiny, bronetransportery* (Kiev: Defense Express, 2011)
Zubov, E. A., *Dvigatel tankov* (Moscow: Informtekhnika, 1995)

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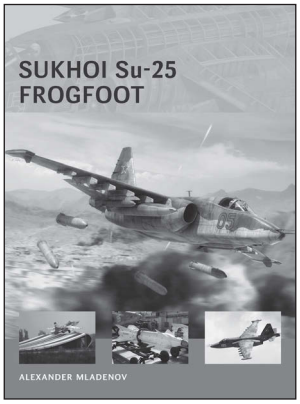

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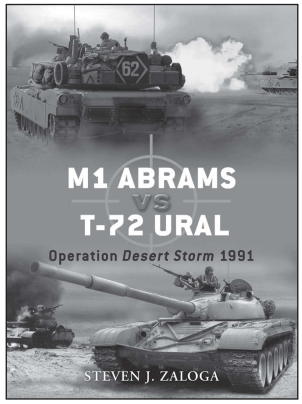

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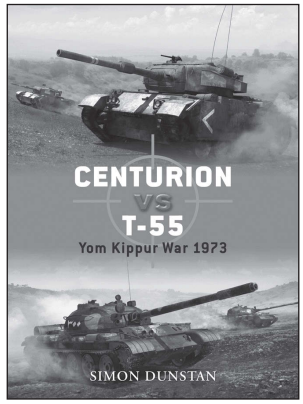

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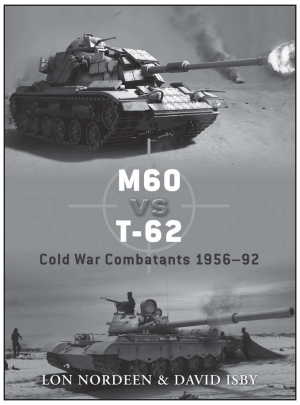

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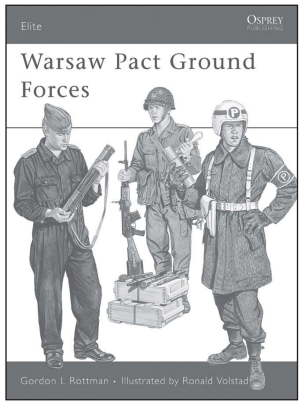

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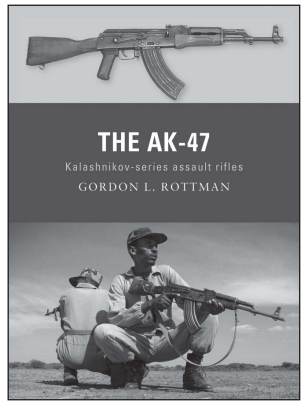

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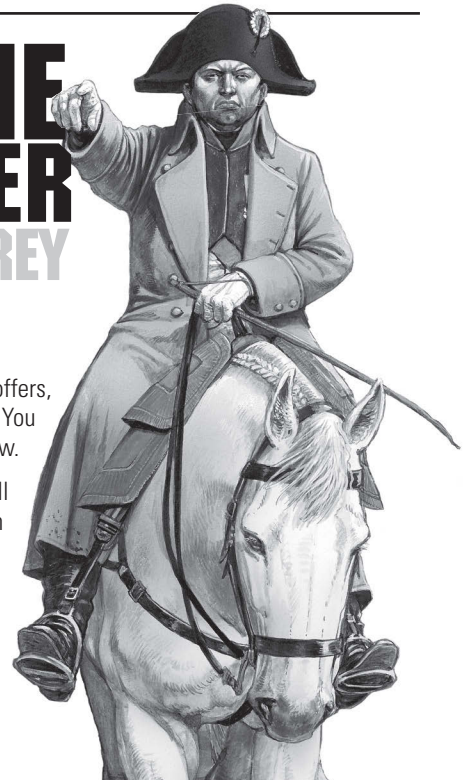

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